Motorship

New York Seattle San Francisco

December, 1923

MARINE DIESEL ENGINES
FOR ALL CLASSES OF SHIPS

M. S. MUNCOVE
Length 353'6", Width 43'6", Depth 27'6"
Draft 23'6", Deadweight Capacity 4125 Tons
Single Screw, 1200 I.H.P., Oil Engine

McINTOSH & SEYMOUR
CORPORATION
MAIN OFFICE AND WORKS - AUBURN, N.Y.

Vol. 8, No. 12 Price, 25 Cents

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EXCLUSIVE technical and non-technical articles on design, construction and operation of oil-engines and motorships by the world's foremost writers on marine engineering.

Motorship

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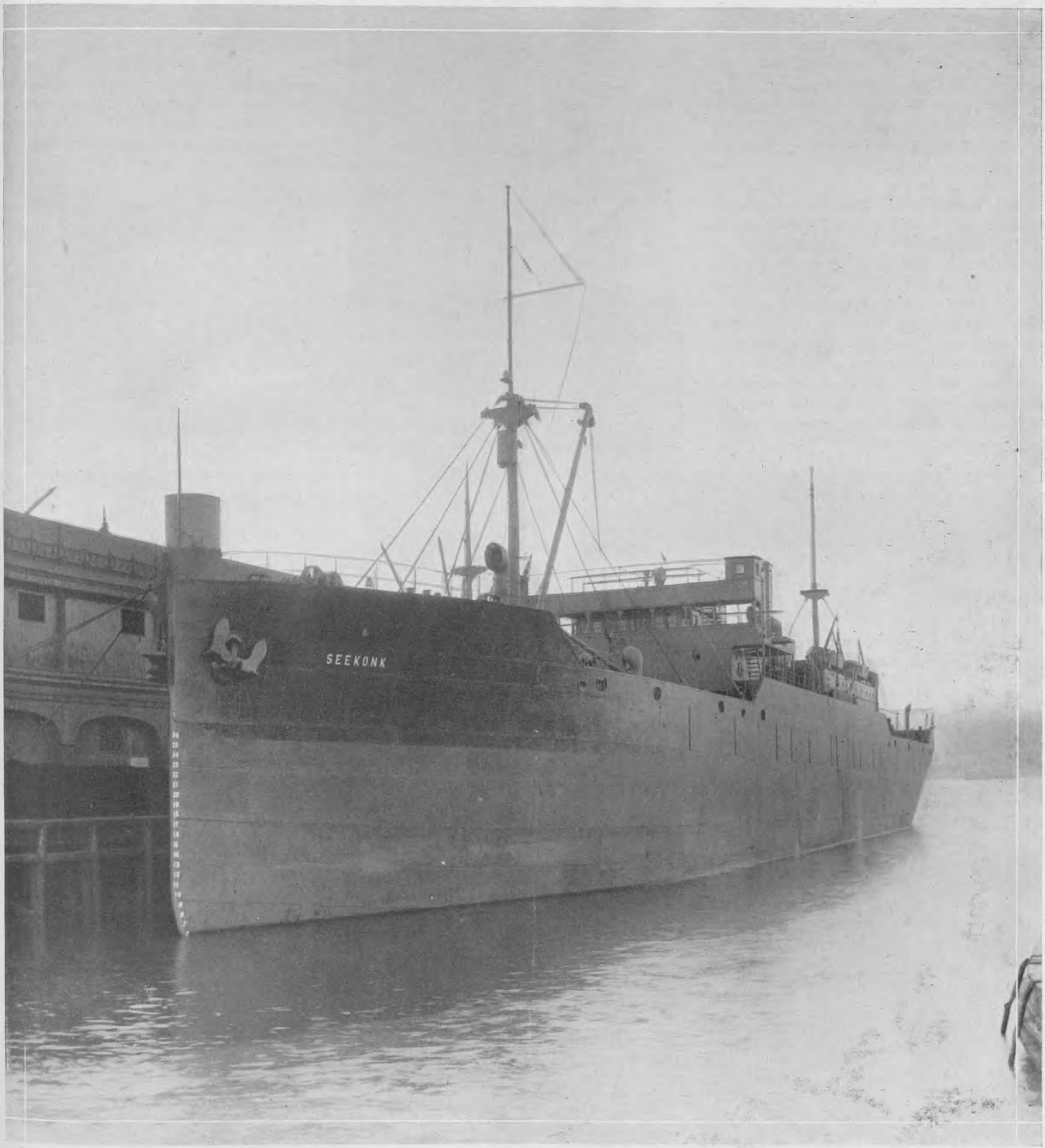

FROM OPERATING LOSS TO SUBSTANTIAL PROFIT

This Hog Island Ship *Seekonk* reduced her fuel-bill $30,000 per year, and increased her net-cargo capacity by 1,000 tons by scrapping her steam plant and replacing it with a Diesel Engine. The Shipping Board will sell similar vessels for conversion at $5 to $7 per ton, and Congress will soon authorize a loan of two-thirds of the total ship and conversion costs which is between $40 and $55 per ton, affording opportunity for securing first-class motorships at lower cost than they can be built abroad. (See Next Page.)

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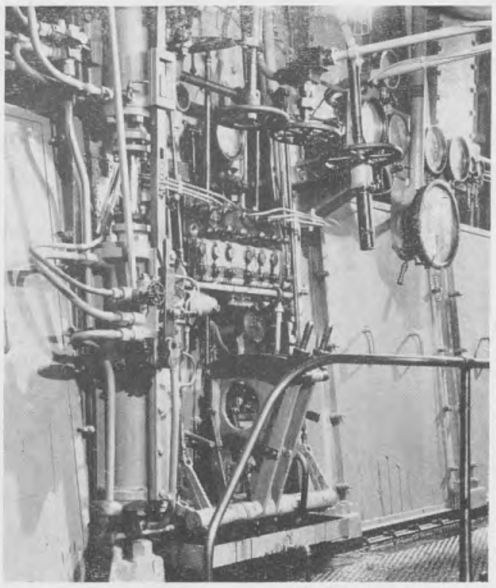
SEEKONK Reduces Fuel-Bill $30,000 Per Year

All the Rest of the Hog Island A-Class Steamers Can Do Likewise If Converted to Diesel Power

WITH a measured fuel-consumption of 0.292 lb. per i.h.p. hour on the SEEKONK for all purposes, the Cramp firm has made a remarkable showing with the long-stroke type of Burmeister & Wain engine which it has taken under construction at Philadelphia. The measurements were made during SEEKONK'S passage around from Philadelphia to New York, where she was open for exhibition during Marine Week and where delivery was made to the charterers, who are the United American Line.

Extra interest attaches to the measured fuel-consumption of the SEEKONK'S machinery because it gives a true and unassailable line of comparison on the Hog Island A-class of vessels, when propelled by Diesel power and steam, respectively. These ships present one of the best groups of Shipping Board tonnage available for purchase at a nominal price under the special terms of sale for conversion to oil-engines. Their performance under motor-power is therefore a matter of wide concern, and the SEEKONK trials throw a lot of light and understanding on it.

Let us deal first with the respective ship performances, and then consider later the achievement in the fuel economy of the Cramp engine.



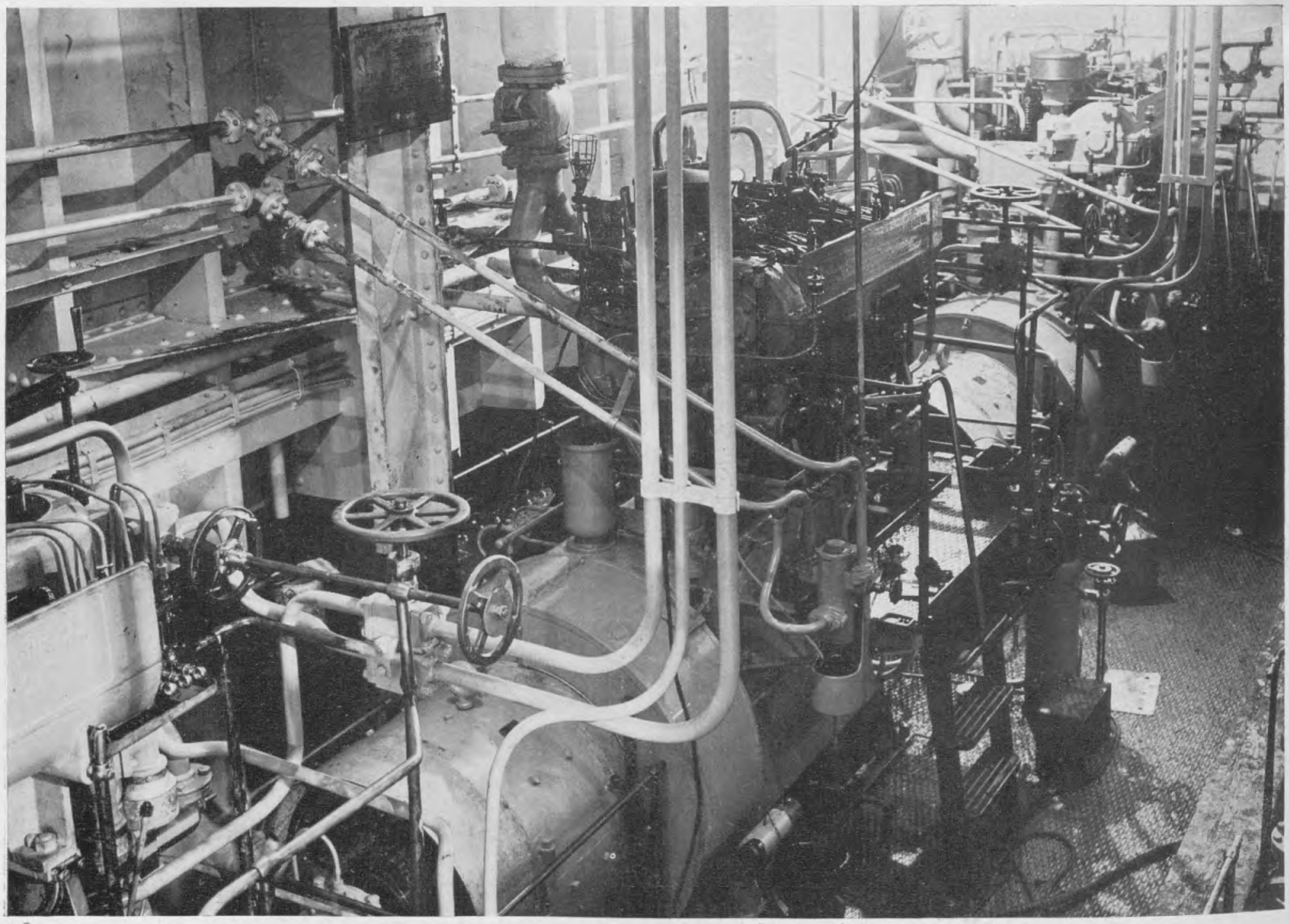
Control mechanism of the *Seekonk's* engine

SEEKONK was a Hog Island A-steamer herself, a little better than most of the other 119 in her class, and for that reason selected by Cramp's in preference to any other vessel in that large family. By Shipping Board rating these boats are known as 7,500 d.w.t. vessels. Actually they seem to average closer to 7,750 d.w.t.

When the SEEKONK was to put to sea with oil-fired boilers, Curtis turbine and single-reduction gear to drive her, she would log about 10¼ or 10½ knots on a daily consumption of around 27 tons when loaded down to 21 ft., 22 ft. or even 24 ft., which is about what these ships draw with a good cargo. A difference of 2 ft. draft, either more or less, is absorbed in the average performance on a number of voyages, just like the weather or a little further dropping of turbine efficiency. All items and conditions and circumstances rolled up together over a period of time gave this average:

(1) *Ship*	*Sea-speed*	*Fuel consumption*
Steamer SEEKONK (Before conversion)	10½ knots	27 tons per day

Take a bunch of Hog Island A-boats, however, and their average will not be so good as that just quoted. Figures gathered from the performance of seventy (70) of them, on a total of nearly two hundred and fifty (250) voyages, with mean drafts varying between 19 ft. and 24 ft., but less than 22 ft. in the case of 56 of the steamers, have given the following averages:



The auxiliary Cramp-Diehl Diesel-electric generating sets in the engine room of the *Seekonk*

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(2) *Ships*	*Average Sea-speed*	*Average fuel consumption*
70 A-steamers (av.)	10.3 knots	29 tons per day

As we write, the SEEKONK as a motorship has not been loaded, and therefore her actual sea-speed with about 22 ft. draft cannot yet be given from a log. But her daily consumption is known, having been measured at full power on the passage from Philadelphia to New York with ourselves, among others, aboard, so we write from first-hand knowledge. Along the Jersey Coast with a strong breeze abaft her, but with the propeller about one-quarter clear of the water, she made 11¾ knots all the way. Judging as best one can from the conditions then prevailing, it appears likely she will average over 10¾ knots on the regular intercoastal service into which she will now enter. Her average performance will thus be:

(3) *Ship*	*Sea-speed*	*Fuel consumption*
Motorship SEEKONK	10¾ knots	7.3 tons per day

Do not make any mistake about the maximum daily consumption of the converted SEEKONK. There it is: 7.3 tons for evermore. The engine cannot burn an excess. It may be less later. In this respect the contrast between Diesel-engines and steam-machinery is as fixed as were the laws of the Medes and the Persians. Try to give a Diesel engine more than her regular quantity of fuel, and she will refuse it. On the other hand, try to get the full power out of your turbine with the same fuel-consumption that was shown once on a contract trial, and you will be surprised how much more oil is needed. A steamer will burn and waste oil beyond any oil producer's dreams of avarice.

Vessels in the intercoastal service can buy "Diesel-oil" at San Pedro for $1.00 per barrel at present prices and contract for it on that basis for 12 months. A steamer might buy a lower grade at $0.90 per barrel. This would make the daily cost of fuel in the three cases:

(4) *Ship*	*Cost of Fuel*
Steamer SEEKONK (Before conversion)	$170.10 per day
70 A-steamers (average)	$182.70 per day
Motorship SEEKONK	$ 51.10 per day

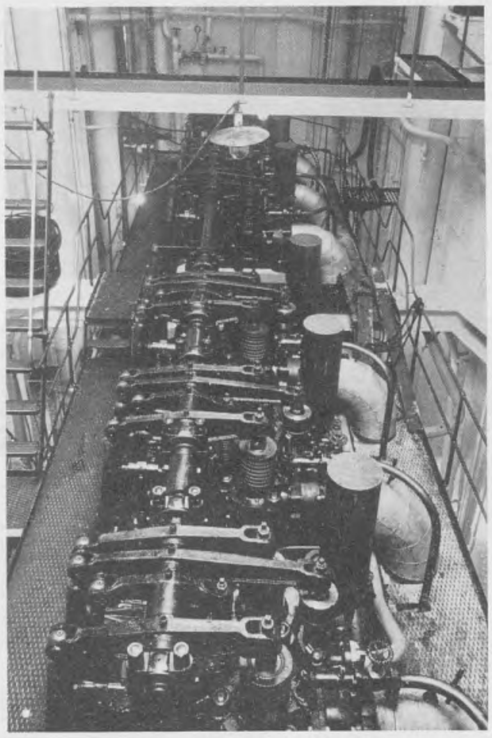
This may seem like reducing the daily cost of fuel on the motorship nearly to the vanishing point, but the figure is correct: $51.10 for fuel to drive a 7,750 d.w.t. vessel along fully loaded at about 10¾ knots for 24 hours. If one calculates the fuel bill for a year, the showing is very remarkable. The calculation can be made first with 125 lay days and secondly with 165 days in port, thus:

(5) *Ship*	*Annual Fuel Bill* (240 days at sea)	*Annual Fuel Bill* (200 days at sea)
Steamer SEEKONK (Before conversion)	$40,824	$34,020
70 A-Steamers (Average)	$43,848	$36,540
Motorship SEEKONK	$12,264	$10,220

In either case the annual fuel-bill of the SEEKONK will be so low that steamship owners, accustomed as they are to the considerably heavier bills of their vessels, must find the comparison difficult to accept. And small wonder—because the SEEKONK, fully loaded, will burn about the same amount of oil per day *at sea* as any steamer of the Hog Island A-class burns *in port* in 24 hours!

Statistics show that the average daily port-consumption of these steamers is about 6½ tons, or just about the same amount as the motorship SEEKONK burns each day at sea. Does it not seem like taxing the credulity of the steamship owner to ask him to believe this? Yet, what else can we do? There are the authenticated steamer costs, and here are the measured motorship figures. We set them out side by side, and if the contrast seems ridiculous to the steamship owner the fault must be laid to the inefficiency of the steamer and not to us.

To supply the deficiency of data concerning the average daily port-consumption of the motorship SEEKONK we will not have resource to any estimates based upon assumptions, and therefore, perhaps, unconvincing to a dyed-in-the-wool steam man,



Looking down on the cylinder heads of the Burmeister & Wain type in the *Seekonk's* engine-room

but will take the figures from the motorship WILLIAM PENN, a larger vessel, with more powerful winches, bigger pumps, larger ice machine, etc., and therefore sure not to have such a small port consumption as the SEEKONK will have. On the WILLIAM PENN, when the winches are working from 8 a.m. to 5 p.m. and the pumps, ice-machine, lighting, etc., are in service the full 24 hours, the daily consumption is about three barrels of 42 gallons each. When the winches are not used the fuel-consumption is about two-thirds of a barrel during the whole day and night. As an average, computed over the entire lay time of the year, the WILLIAM PENN is below two barrels 24 hours in port. If that figure is used for the motorship SEEKONK it is penalizing her.

(6) *Ship*	*Fuel-Consumption in Port*
70 A-steamers (average)	6½ tons per day
Motorship SEEKONK	⅓ ton per day

This comparison brings out the very striking fact that, if the motorship in question has 125 lay days per annum, her port consumption for the entire year will be less than the steamers of her Hog Island A-class burn in 1½ days at sea. That is worth pondering over. If she loses 165 days in port her fuel-consumption under that heading for the whole twelve months will still be less than she used to burn in two days at sea when she was a steamer. On the other hand, consider what the steamer burns in port:

(7) *Ship*	*Port Fuel-Bill* (125 lay days)	*Port Fuel-Bill* (165 lay days)
70 A-steamers (Average)	$5,115.60	$6,123.60
Motorship SEEKONK	$ 294.00	$ 385.00

Thus it appears that what the average steamer of this class burns in port alone during the year costs just about two-thirds of what the motorship's fuel bill for all purposes will be during a year composed of 200 days at sea and 165 days in port.

(8) *Ship* (200 days at sea and 165 days in port)	*Annual Fuel-Bill*
Steamer SEEKONK (Before conversion)	$40,143.60
70 A-steamers (average)	$42,663.60
Motorship SEEKONK	$10,605.00

It is thus proved that the annual saving effected by the conversion of the Hog Island A-class of steamer to motor-power amounts on the fuel-bill alone to $30,000. If the cost of fuel-oil increases, as it undoubtedly will within the next few years, this saving will be correspondingly increased, yet still show a tremendous saving over coal. It is such a remarkable economy in itself that we will not run the risk of letting it get out of sight amongst all the other economies that can be derived from the conversion of a vessel of this type.

On the passage from Philadelphia to New York, the motorship SEEKONK met varying conditions of water and weather that altered the engine revolutions between 90 and 94 at full power. The designed speed is 90 r.p.m., and there was one period of three hours during which the revolutions approximated this result:

(9) Fuel oil......0.902 gravity (7.52 lb. per gal.)
Mean engine speed................90.9 r.p.m.
Power, main engines..............2,410 i.h.p.
Power, aux. engine.................100 i.h.p.
Total power, machinery...........2,510 i.h.p.
Fuel consumption, per hour, 98.8 gals. (abt. 2½ bbls.)
Fuel consumption, per hour.........705 lbs.

Fuel consumption per i.h.p. hour, referred to main engine—0.292 lb.

Fuel consumption per i.h.p hour referred to all engines—0.281 lb.

In these measurements the oil burned under the donkey-boiler and used for heating only has been omitted. It amounts to 0.25 ton per 24 hours. The consumption by the auxiliary engine includes not only the fuel used for driving the waterpump and lubricating-oil pumps serving the main engine, but also the fuel burnt for all electric power and lighting, thus covering the entire ship's service.

The main Diesel engine is designed for 2,250 i.h.p., and it has been found that the average power taken out of the auxiliary engine is 100 i.h.p. The daily fuel consumption at sea, therefore, under normal load will be:

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(10) Donkey-boiler, per 24 hours........0.25 ton
Machinery, per 24 hours,
(Main engine, 2,250 i.h.p.)......7.05 tons

Auxiliary, 100 i.h.p..............7.30 tons

In this article we have made no mention of the importance of the earning value of the 17,768 additional cubic feet of cargo space gained by her conversion to Diesel power. This is another story to be told after the vessel has been in service for a certain period. The sum total of the gains cannot be estimated in advance. It represents about 1,000 tons more net cargo per one-way voyage whenever fully loaded, due to the saving of fuel carried. Then there is the wage and victual question, because the SEEKONK today only carries eight men in her engine-room.

Shipowners who are interested in the foregoing economies should read the complete story of the technical details of her conversion given and illustrated on pages 763 to 767 of our November issue. This particular issue of MOTORSHIP is completely sold out, but a reprint of the article can be obtained from the Cramp shipyard.

There are more than 100 vessels of the Hog Island A-class which can be made to show similar savings by conversion. Many of these boats can be purchased from the Shipping Board at about $7 per ton provided the owner will guarantee to convert her to oil-engine power. Here is an excellent opportunity for American shipowners and ship-operators to make a sound investment and secure for themselves modern motorships at a very low cost and on easy terms, and of a type sufficiently economical and reliable to enable them to compete with Europe's finest motorships and steamers in the world's trade.

It is expected that Congress, late in December or early in January, will authorize two-thirds of the value of the ship and cost of the conversion to be loaned to domestic shipowners over a long period, at moderate interest.

Motor Tugs Cut Towing Costs in Half

Demonstrated by Operating Costs of Transmarine Corporation's Steam and Motor Tow-Boats

DUE to the satisfactory performance and economy of operation of its first three Nelseco-engined tow boats, during the season of 1922 on the New York State Barge Canal, the Transmarine Corporation, Canal Division, ordered last Spring two additional tugs, TRANSCO Nos. 4 and 5, for service during the present season. The only point, concerning which the Transmarine Corporation was undecided when ordering the first three tow-boats, was the power best suited for work on the Canal; consequently two sizes were built in order to judge by actual results. They were dimensioned as follows:

TRANSCO No. 1—overall length 60 ft. 0 in., beam 17 ft. 6 in., draft 7 ft. 6 in., and powered with one 180 b.h.p. six cylinder Nelseco engine.

TRANSCO Nos. 2 and 3—overall length 67 ft. 0 in., beam 17 ft. 6 in., draft 7 ft. 6 in. and powered with one 240 b.h.p. eight cylinder Nelseco engine.

Performance showed that the smaller size, powered with 180 b.h.p. did all work required, operated slightly cheaper, was easier to handle and cost less to build. This was the type adopted therefore when the two new boats were ordered, which have now been in daily operation on the Canal for some time past, and are emphasizing the remarkable superiority of the Diesel engine for this type of heavy duty work.

They were built by the Hildebrandt Shipyard, at South Rondout, N. Y., are 63 ft. in length overall, 17 ft. 7 in. breadth and draw 7 ft. 6 in. of water. The engine equipment consists of a six cylinder 180 b.h.p. directly reversible Nelseco engine, developing its full power at 350 r.p.m. The engine can be slowed down to such an extent that it renders the same flexibility of maneuver as the steam engine. An electric lighting system, consisting of a 32 v. Electro Dynamic generator belted to the main engine and a battery capable of carrying all lights for 24 hours, is fitted in each boat. There is also a small auxiliary air compresser, driven by a 5 h.p. Palmer gasoline engine.

With the addition of TRANSCO Nos. 4 and 5, the unpleasant and expensive necessity of chartering steam tugs will be avoided and the Corporation, due to the above mentioned advantages, will move larger quantities of freight than formerly.

Actual operating expenses during 1922 of the TRANSCO Nos. 1, 2, and 3 in comparison with the steam tugs LIBERTY and CHARLOTTE, which were run under charter, are shown in the accompanying Tables I and II. The service performed by these tugs was the towing of five steel barges, drawing 9 ft. 6 in. carrying approximately 2,000 tons of cargo.

In the running costs of the Diesel boats—Col. 5—25 per cent. of initial cost was allowed for depreciation, insurance, taxes and interest on the investment, in addition to the wages and subsistence of a double crew to each tug. If the "days in commission" of

This Nelseco-powered canal tug does real work economically. She is 100% more efficient than a steam tug

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Transco No. 1 going up-stream with a full load

TABLE I: PERFORMANCE

Name of Tug	Days in Com-mission	Total Tons Towed	Total Miles Towing and Light	Average m.p.h.
Transco No. 1	175	28,023	6,675	2.22
Transco No. 2	205	35,005	6,352	2.14
Transco No. 3	167	26,462	5,945	2.30
Liberty (1921)	230	30,656	7,853	2.07
Charlotte	74	22,702	1,803	1.70
	Col. 1	Col. 2	Col. 3	Col. 4

TABLE II: COST

	Per Season			Per 1000 Ton Miles		
Name of Tug	Running or Charter Cost	Fuel Costs	Operating Costs	Running or Charter Cost	Fuel Cost	Operating Costs
Transco No. 1	$9,992	$1,740	$11,732	$0.053	$0.0093	$0.062
Transco No. 2	11,705	2,488	14,193	0.053	0.011	0.064
Transco No. 3	9,535	1,609	11,144	0.061	0.010	0.071
Liberty (1921)	16,560	9,230	25,790	0.033	0.069	0.017
Liberty*	16,560	11,075	27,635	0.069	0.046	0.115
Charlotte	4,526	2,500	7,026	0.110	0.061	0.171
	Col. 5	Col. 6	Col. 7	Col. 8	Col. 9	Col. 10

all tugs are reduced to a common basis, and Col. 5 changed proportionately, it will be seen that the running costs of the Diesel tow boats are considerably lower than the corresponding charter cost of the steamers.

The column showing fuel costs illustrates the remarkable economy of the highly efficient Diesel engine when compared with the relatively inefficient steam engine. Cols. 8, 9 and 10 give the costs of towing 1,000 tons per mile. *The average of the three* TRANSCO *tugs shows them to be 100 percent more efficient than the average of the three steamers.* Furthermore, throughout the life of the Diesel engine, its fuel consumption will not vary more than 5 percent.

All of the above figures represent actual money—not estimated costs, but hard cash paid out. Due to the high depreciation rate, about 17 per cent., which the Transmarine Corporation is charging against these boats, they will be entirely written off the books at the end of six years. Thereafter the Corporation will enjoy many years of satisfactory service at increased gains.

Aside from the direct profits, Diesel propulsion in tugs or towboats has many other advantages. By the use of fuel oil instead of coal, the crew gains easier labor, shorter fuelling hours and practically no discomfort, while the owner has a boat which maintains a better average speed because the human factor is eliminated from the boiler room, his craft is fuelled in less time, the usually necessary repainting after coaling is avoided, the storage and disposal of ashes is abolished, a larger radius of action is obtained and, therefore, fuel can be taken aboard at the most economical points. Apropos of fuelling, TRANSCO No. 1 fuelled at Albany on October 5th ran to New York, arriving there on the 7th, left on the 11th for Buffalo, arrived there on the 20th, and returned to Albany on the 31st. *Twenty-eight days without refuelling, covering a distance of 1,100 miles.*

During the winter period when the Canal is frozen up, the tugs are used in and around Newark Bay and New York Harbor, and are engaged in shifting the Transmarine Line cargo ships, and in handling barges. By slowing down the engine, the tugs are able to ease barges in and out of slips with the flexibility of the steam drive. Furthermore, the Diesel tug saves its owner considerable money by eliminating the fuel losses, caused by inevitable delays and standing-by, in this class of work. As the Nelseco engine can be started in less than one minute's time, the engineer shuts down immediately after the boat has temporarily finished working, whereupon the fuel cost ceases.

Recently, the Transmarine Corporation purchased a hull, 100 ft. long 24 ft. beam and 11 ft. draft, for which it ordered a six cylinder 600 b.h.p. Nelseco engine to be installed.

* The Liberty was on charter in 1921 and coal was cheaper. A fair criterion would be to add a fifth more to the cost of fuel for this tug, if the tug had been in operating during 1922. Coal along the Canal in 1922 ran as high as $12.50 per ton.

Conversion of Steamships to Motorships

Some Considerations Outlined Before the Society of Naval Architects and Marine Engineers on November 9, 1923

(Copyrighted by the Society)

By ROBERT HAIG
Vice-President, Sun Shipbuilding Co.

IN considering the question, building motorships or converting steamships to Diesel motor-driven ships, American shipbuilders and shipowners have had a peculiar situation to deal with. The Shipping Board owned and held for disposal an enormous number of ships, most of which had been constructed during the war or immediately succeeding the war, and which were more or less acceptable as merchant ships in the ordinary run of business.

(a) Leaving out of consideration the ships of 500 ft. and over, what the shipowner had to choose from was straight cargo boats, also oil tankers, ranging all the way from 3,500 d.w. to 12,500 d.w. tons, single-screw type, fitted with steam turbines, reduction gears, water-tube boilers; steam turbines, reduction gears, Scotch boilers; triple-expansion steam engines, water-tube boilers; and triple-expansion steam engines with Scotch boilers.

(b) A few ships were built of the twin-screw type, but these were early disposed of and did not enter into the large mass of ships that were still on the market for sale under various conditions of purchase and operation.

Owing to the conditions arising in the oil industry during the latter part of 1922 and the first half year of 1923, a very firm market developed for oil tankers for a time, affording the Shipping Board an opportunity to dispose of probably 60 per cent. of the then existing fleet of tankers at a price that no shipbuilder, either here or elsewhere, could ever hope to duplicate, but probably the prices obtained were a good trade considering how many tankers

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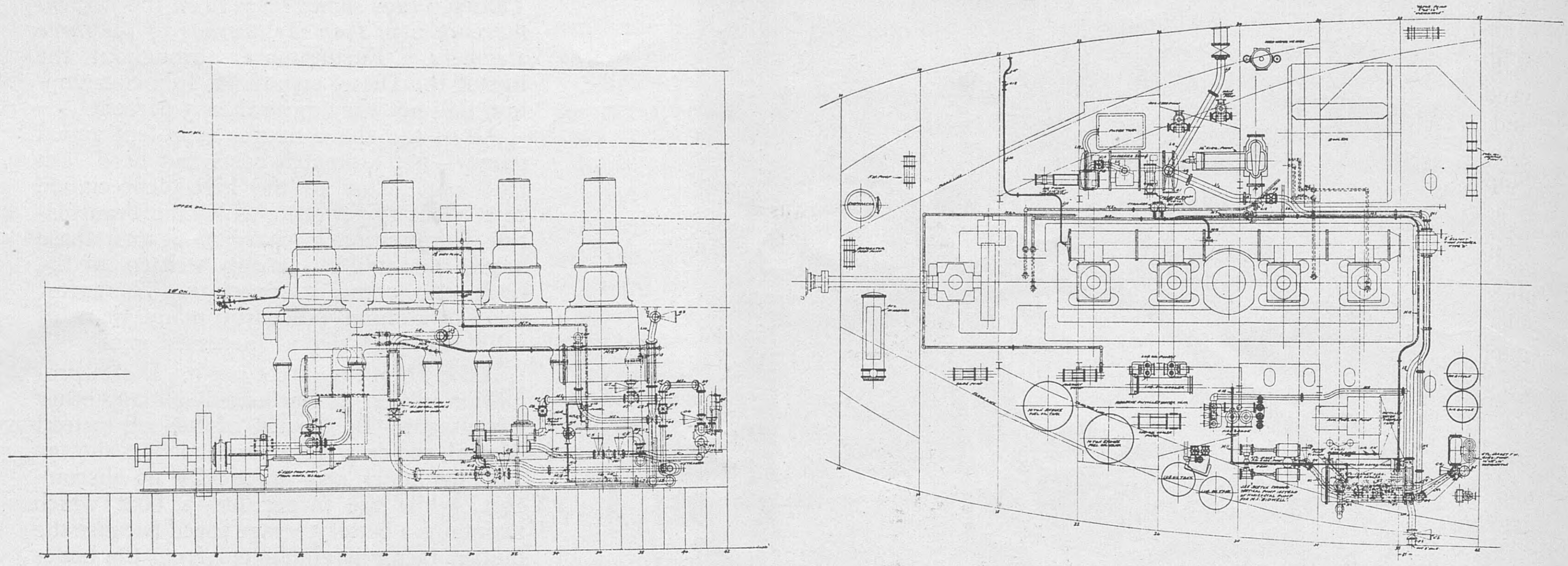


Engine-room plans of the motorship *Bidwell* as she is today

the Shipping Board had on hand, and the further fact that they have no trade of their own for those ships, and also that ships of this type were almost entirely owned by those firms who were engaged in the oil business. The number of tankers sold has relieved the pressure on the market for that type of boat, and results have demonstrated the fact that, with a general increase of this business, the tanker market will shortly be found to be very bare of tonnage.

One of the first questions we had to consider on the conversion of an oil tanker to motor drive was whether the vessel should be arranged for Diesel-electric-driven auxiliaries or adopt steam auxiliaries by retaining one of the main boilers and such of the present steam auxiliaries as were suitable for the new conditions. The arrangement with steam auxiliaries reduces the cost of conversion if the units already on board are in good condition and can be worked into the new scheme of things found on a Diesel motor-driven ship, but such an arrangement, while it shows very gratifying results in economy of operation and a certain reduction in cost of conversion, can hardly be expected to give such favorable returns as we have a right to expect will be obtained in a more complete Diesel unit.

I have no hesitation in stating there are indications that as new tankers are laid down, the requirements for large boiler power for pumping-out cargo will be dispensed with, and tankers will be built with main Diesel motors and auxiliary motors, coupled to electric generators, with cargo pumps driven by electric motors, and such heating as may be required for fuel will be obtained from an auxiliary heating generator, deriving its heat from the waste gases from the main and auxiliary motors.*

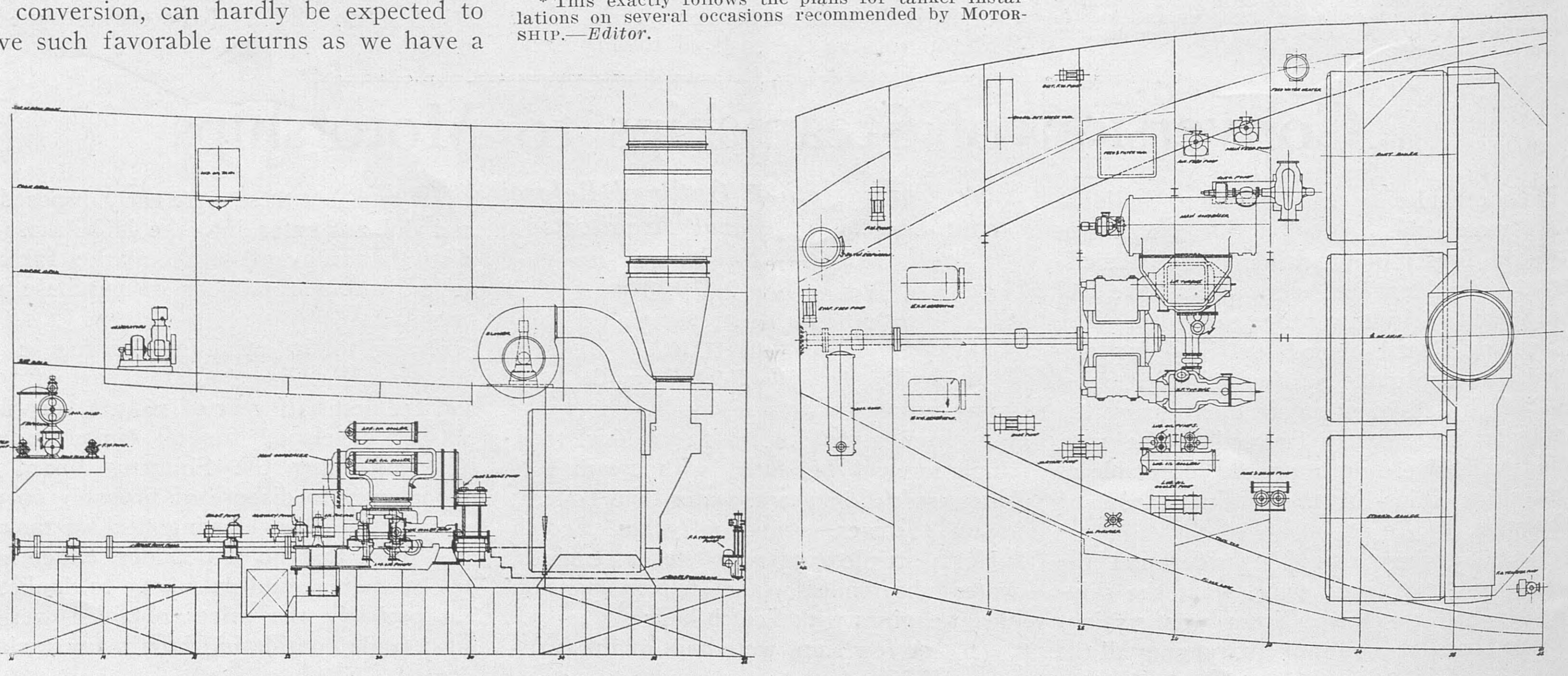
When the shipowner who handles cargo and passenger ships deals with the question of fitting Diesel motors, he is not immediately concerned with the consideration of retaining boiler power, beyond such small power as might be required for purposes of heating, which is only a minor matter.

In dealing with a general cargo-boat, the same considerations have not had to be given to cargo handling as in the tanker, as we have no difficulty in obtaining electric-driven winches, windlass and steering gears of the highest type, which we have every reason to believe will be found much more economical in maintenance. With the electric auxiliaries, steam for power purposes can be entirely eliminated, and we thereby obtain the best conditions for a Diesel motor installation, as there is no question of doubt but what an all-Diesel installation is the ideal outfit.

Cargo boats engaged in overseas trade, as a rule, have long trips to make, where the accumulated savings of fuel and reduced fuel weight carried are of great importance, as the purchaser of fuel in some foreign ports is a very serious expense. One further consideration that must always be recognized in the driving power of a Diesel engine is that the power throughout the twenty-four hours does not fluctuate, as is so usual in steam-driven ships. With reliable running assured (and every day the Diesel engine is becoming more so), the shipowner can count with a very satisfactory degree of accuracy the actual operating days his vessel is going to require to reach a certain destination.

Our experience has shown us that the ships now owned by the Shipping Board

* This exactly follows the plans for tanker installations on several occasions recommended by MOTORSHIP.—*Editor.*



Engine-room plans of the steamer *Bidwell* before conversion

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can, with very great advantage, be converted to Diesel motor-driven ships, and it will be found later that in the higher powered passenger boats the savings in fuel and space will be still more substantial. The adaptability of the general run of the Shipping Board ships to Diesel motorships is admitted, and several shipbuilding firms are working on different types at the present time. The Sun-Doxford type for the power developed on a single screw is probably the shortest engine being built in this country at the present time, and, as has been shown, it can be placed in the same space as formerly occupied by a turbine job of similar power. [Dimensions and weights of the leading American Diesel engines can be found on page 32 of the 1922 MOTORSHIP Yearbook—EDITOR.]

The Sun Shipbuilding & Dry Dock Co. in the early part of the present year, in the adjustment of their business with the Shipping Board, purchased from the Shipping Board two oil-tankers with Scotch boilers and geared turbines, 10,200 tons d.w, and one general cargo boat, 11,800 tons d.w. with Scotch boilers and geared turbines, with the intention of converting these vessels from steam drive to Diesel-motor drive, by removing the existing steam machinery and installing a Sun-Doxford two-cycle opposed-piston oil engine of 3,000 shaft h.p. each. The tankers, which have been dealt with first, were received at the Sun Shipbuilding Co.'s yard at Chester as follows: S. S. MILLER COUNTY, March 30, 1923, and the S. S. BIDWELL, April 19, 1923.

(a) The vessels were placed in dry dock for examination of conditions and with a view to consider what, if any, structural alterations on the after part of the vessels would be required. The vessels were later taken off the dock and put in the wet dock, and the work of dismantling of the machinery proceeded with. The main engines and the center and starboard main boilers of the two tankers were removed, and such steam auxiliaries as were unsuitable for the new power were also removed. The existing auxiliaries that were retained were relocated, and new foundations built and such other auxiliaries as were required were provided for, the main engine foundations were built and a new main motor of the four-cylinder two-cycle type, 3,000 shaft h.p. installed, with the new auxiliaries arranged and located as shown. It will be noted that the port boiler appearing at the forward end of the machinery space is retained in its original position as when the vessel was a steamer; the only work done was to case the boiler in, except at the fore end, where the entrance is into the fireroom. This arrangement lends itself very readily to a good installation, causing the minimum of structural alterations.

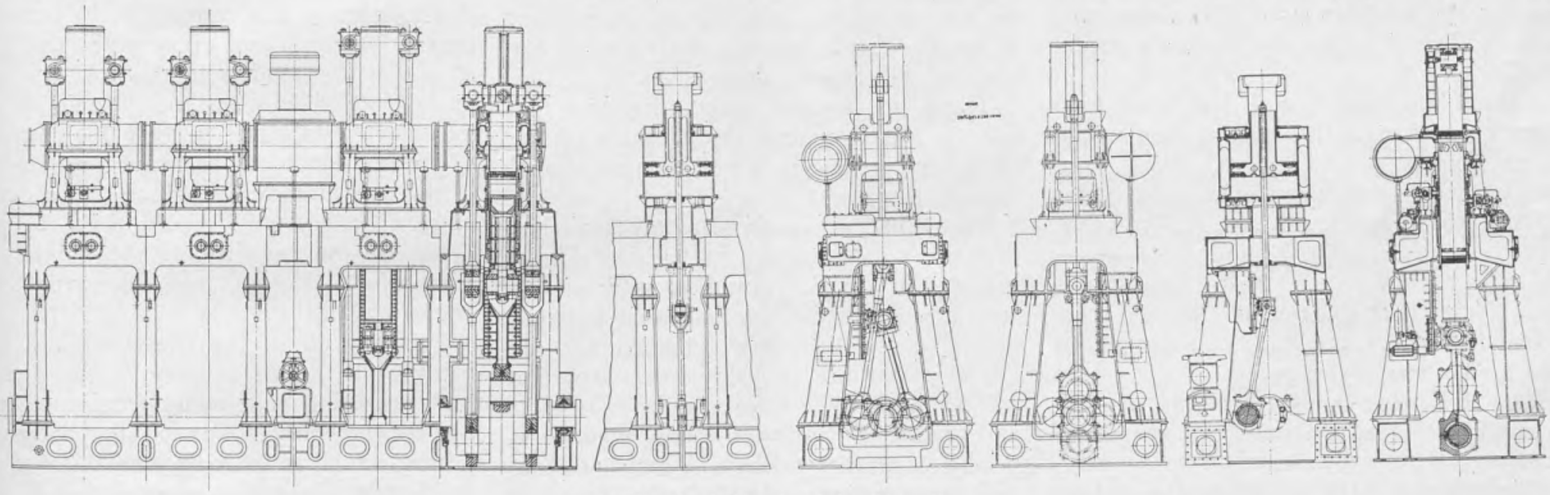
The whole of the machinery was installed with good, generous room for accessibility within the confines of the original bulkheads when the vessel was taken over. A new stern tube and shaft were fitted for the increased power put into the vessel over and above that previously developed with the turbines. The work proceeded very satisfactorily. The whole ship was overhauled and reconditioned in all tanks, quarters, etc., the vessel being docked the second time and put in good condition and painted, and, after the work had been completed, dock trials were made while the vessel was lying at the yard. The engines worked uncommonly well, without the slightest vibration. I may state that we were without data as to whether these hulls would set up vibration with this machinery being so far aft, but we were agreeably surprised to find that the working of the machinery developed a steadiness beyond that obtainable, even with our quadruple engines.

The M. S. MILLER COUNTY, after the dock trials at the yard, was subjected to trials on the Delaware River, when the motors were found to work very well indeed. The ease of handling the motors by the engine-room crew was all that could be desired. After some minor adjustments had been made the vessel was sent on a sea trial, but after three days at sea the vessel was recalled by wireless, as it was found that the lubricating oil was emulsifying and making it difficult for the forced lubricating system to work properly. On the vessel's return it was found that cylinder lubricating oil, also the lubricating oil used in the bearings, when combined with slight leakages of fresh water, caused trouble. This was a condition that had not been sufficiently considered, and while it was annoying it no doubt had its compensating values in other respects. The whole of the lubricating oil was discarded, the entire system cleaned out and new oil supplied, which was worked with entire satisfaction.

The M. S. BIDWELL also had motors of the same size and type installed as on the MILLER COUNTY, and after the necessary dock trials and river trial this vessel was sent on a trip to California. Neither of the motors in these two vessels had any shop trials on a test bed, yet they worked at the first trial and each succeeding trial without any failure whatever.

There is nothing mysterious in the construction of Diesel motors that need deter shipowners from adopting this type of power; the foremost marine motors on the market today are the product of good design and workmanship based on sound engineering principles. We are all familiar with the various developments from the low-pressure compound up to the present-day geared turbine, causing revolutionary changes, and at each step an improved economy was sought after; sometimes the gain was small, not exceeding 5 per cent., and it is not overstating the case when we assert that the gain from the compound engine up to the geared turbine of today has not exceeded 20 to 25 per cent., taking all sizes of steam power on an average basis, yet the gain at each step was sufficiently encouraging to go forward. The shipowner was keenly alive to the value of the lowered fuel cost per horsepower and willing to invest his money in ships that would reduce his fuel bill and machinery weights.

If such economies were considered sufficiently advantageous to warrant investing in a new type of power, how very much more attractive from an earning standpoint should the Diesel motor be considered when we can offer the owner a saving in fuel alone of 55 to 65 per cent. Further, when we consider the many advantages a lower fuel consumption means, it can be appreciated that it is not only lessened cost for fuel consumed that improves earnings, but less fuel consumed means less fuel accommodation in the shape of bunkers required, less fuel carried means an increased capacity for more cargo carried and a greatly increased steaming radius of the vessel.



Sun-Doxford Diesels of the *Bidwell*

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Or take the economy resulting from the reduced quantity of fuel required; the Diesel tanker could take on 644 tons of fuel at San Pedro, where fuel is cheapest, and have enough for the round voyage and still allow the vessel to carry to her full normal capacity, whereas if the steamer desired to take advantage of the low cost of fuel and fill up her bunkers for the round voyage, it would mean shutting out about 800 tons of cargo, or go into some port during the trip for fuel at an increased cost, and, of course, delay.

Take the case of a steamer 12,500 d.w. tons, 3,200 i.h.p., single-screw, leaving California for the east, burning 33 tons of oil fuel per day, which on a 20-day steaming trip is equal to .... 660 tons
Additional for 3 days' spare fuel. 99 tons
Stand by losses raising steam... 20 tons

Total .... 779 tons

A Diesel tanker of same size and power with steam auxiliaries would use 15 tons per day. 20 days at 15 tons..... 300 tons
Additional for 3 days' spare fuel. 45 tons
Stand by losses nil

Total .... 345 tons

Difference, 434 tons, or, roughly, a saving for the round trip of about 900 tons with a Diesel motor-tanker with steam auxiliaries.

Taking the same vessel, but fitted with electric auxiliaries, the consumption would be as follows:
20 days at 10.5 tons per day.... 210 tons
3 days' spare fuel............. 31.5 tons

241.5 tons

Or a saving over the steamer for
one trip .... 537.5 tons
and for the round voyage...... 1,075 tons

The following known weights are set down for comparison only, but are fairly accurate:

The weights here set down for tankers with steam auxiliaries and steam heating and cargo pumping outfit indicate the minimum of structural changes due to conversion to Diesel-motor drive which are probably the least favorable conditions, yet they show remarkable savings over the steamer, but it will be noted when we consider the straight Diesel-motor drive with electric auxiliaries throughout deck and engine-room that we get economies in weight and fuel required that amply repay the extra investment. * * *

It is an undoubted fact that at the present time steamship freight rates dominate the freight market, and when the freight rate drops too low for steamships to make earnings, then the ships must either be laid up as being unprofitable to operate or run at a loss; but one authority has pointed out that in a very few years motorships will dominate the freight rates and by their reduced cost of operation will be able, as they are at the present day, to operate and make profitable returns, while steamships will either be run at a loss or be laid up as being unable to operate profitably, so that shipowners have to consider whether they intend to remain in business and operate ships at a profit (and that is the only known way they can remain for any length of time in business), or take up the question of equipping the vessels with Diesel motors and thereby reduce the cost of operation.

One further advantage the shipowners should bear in mind in considering the question of converting steamships to motorships is the increased value of the shipping property fitted with the Diesel motor. And we are forced to agree that as the number of motor-vessels increase the value of the steamer will rapidly decrease.

There are several points that are frequently raised against the adoption of the Diesel motor, and it is well that we should discuss them here.

First, that we in this country have had little or no experience in building Diesel motors, and that it would be safe to wait until a wider knowledge has been assured; also that the economies claimed for the Diesel motor are probably overstated and will be found to be disappointing in results; and finally, if we do eventually manage to produce satisfactory motors, and the economy of operation is equally so, we have not the men to put on board the ships to successfully operate.

Precisely the same statements were made when America started to build high-class automobiles—to some minds it was fantastic; results today require no elaboration.

Holding strictly to our marine engineering development, we will recall that at every step in the progress of engineering there have been the same identical doubts and fears; when we went from compound to triple, and later to quadruple-expansion engines, with the much increased pressures and temperatures, we were warned of the dangers that would develop. Some few of them did develop both in engines and boilers, but they were gradually improved upon; greater attention to metals and changes in conditions under higher temperature of copper, cast iron, etc., were investigated, and in time the triple and quadruple engines were established with their greater flexibility, higher mechanical efficiency and much reduced fuel consumption. These changes became revolutionary; compound engines were obsolete. A parallel case can be established when the direct turbine and later the geared turbine came into use. The turbine, notwithstanding its multiplicity of parts and fine adjustment required, was in a very short time enormously developed, because it was found eminently suitable for a very wide range of powers, also lesseend weight and lower fuel consumption per horsepower.

While it is an admitted fact that nearly all of the mechanical development here enumerated had its inception abroad, that has not hindered the construction and development in this country in the remotest degree. In each and every grade and type of power the builders in this country have pushed ahead with an energy and success that have established a very high quality of both mechanical accuracy and design. If this has already been done in the developments cited, why should there be any doubt of the capacity of the builders to successfully design and construct the Diesel engine?

Probably all of the Diesel engines now being built in this country at the present time are being built under foreign patents, and very closely following the patentee's design, which is the only wise thing to do, as thereby the builder and owner in this country get the full benefit of the data and experience already gained elsewhere.

The Sun Shipbuilding & Dry Dock Co. is building the Sun-Doxford opposed piston two-cycle Diesel oil-engine closely to the plans and data as furnished by Wm. Doxford & Sons, Ltd., Sunderland, England, out of their long-extended experiments and research. The motors built and installed by the Sun Shipbuilding & Dry Dock Co. on the M. S. MILLER COUNTY and M. S. BIDWELL are the usual Sun-Doxford two-cycle opposed piston type, four cylinders, 22¾-inch diameter, stroke of each piston 45½ inches, 3,060 shaft h. p. at 90 r.p.m. Weight of machinery, including fuel-pump, flywheel, thrust-shaft and Kingsbury thrust, 370 tons. The main motors for the M. S. CHALLENGER are of the same size and type. This vessel, however, will be fitted with Diesel-electric auxiliaries.

Dealing with the last of the charges or objections urged against the Diesel motor—namely, the difficulty of getting capable engineer crews who could efficiently and with the necessary patience and care continue to operate Diesel motors with the

ESTIMATED WEIGHTS OF PROPELLING MACHINERY FOR TANKERS

	Weight of machinery (long tons)	*Fuel-oil required for 25-day trip*	*Total*
S. S. BIDWELL, 10,200 d.w.t., 3 Scotch boilers, 2,700 s.h.p., turbines, gears and steam auxiliaries, including water in boilers	580	800 tons—boiler	1,380
Duplicate of S. S. BIDWELL, 3 Scotch boilers, 3,000 i.h.p., triple expansion engine and steam auxiliaries, including water in boiler	670	875 tons—boiler	1,545
M. S. BIDWELL, 1 Scotch boiler, 3,000 i.h.p., Sun-Doxford Diesel engine and steam aux., including water in boilers	758	375 tons—eng. and boiler	1,133
S. S. PENNA. SUN, 13,000 d.w.t., 4 Scotch boilers, 4,500 i.h.p., quad. exp. and steam aux, including water in boilers	1,000	1,200 tons—boiler	2,200
Duplicate of PENNA. SUN, 1 Scotch boiler, 4,500 i.h.p., Sun-Doxford Diesel eng. and steam aux., including water in boilers	1,007	725 tons—eng. and boiler	1,732
Duplicate of PENNA. SUN, 1 small vertical boiler, 4,500 i.h.p., Sun-Doxford Diesel engine, Diesel and elec. aux.	980	530 tons—boiler	1,510

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same degree of success as they now operate steam engines—may I state just quite briefly our experience. As we are builders, not operators, we decided to operate the tankers M. S. MILLER COUNTY and M. S. BIDWELL through the ship-operating department of the Sun Oil Co.

The Sun Oil Co. appointed the engineers for these vessels in the usual way, but at our request the chief-engineer and some of his assistants came to our yard about two months before the vessels were completed, so that they should get thoroughly familiar with the job. The M. S. MILLER COUNTY arrived at our yard March 30, 1923, and left completed June 26, 1923, or rather less than three months' time was consumed in removing the old machinery, docking the vessel twice, fitting new stern tube and completing the whole installation, including the necessary trial trips. When the vessel left our yard and entered on charter we placed two extra chief-engineers on board, also two experienced mechanics. As this was our first ship with this type of power and we wanted to take considerable data, we considered it good judgment to send the extra men. One of the extra chiefs had been observation engineer on one of the Doxford motorships for six months; the other chief had been responsible for the installation of the machinery. Both chiefs were formerly our guarantee steam engineers. The vessel had then an engineroom crew as follows for each watch for the first voyage: One chief-engineer, one assistant-engineer, one oiler, one fireman, making four men on each watch, with two wipers, also two mechanics on days.

The vessel proceeded to Port Arthur, Texas, and back, making a voyage of seventeen days. At the end of the first voyage one of the extra chiefs was removed, and on the completion of the second voyage the other chief and extra men were removed, since which time the vessel has continued to operate with the same crew as is required for a similar size and type of steam tanker, with the greatest success.

In all, up to date the M. S. MILLER COUNTY has made about five or six trips, equal to about 21,000 miles, with most satisfactory results. The engineers like the ships; there is much less work to do on watch and in port, and it appears to be quite established that when once the men get over the first feeling of strangeness they handle the motors with celerity and confidence.

Bessemer to Build Atlas-Imperial Diesels

Manufacturing Rights for Atlas-Imperial Oil Engine Acquired by Bessemer Gas Engine Co., Grove City, Pa.

IT is not without pleasure we announce to our readers the Bessemer Gas Engine Co., of Grove City, Pa., have acquired exclusive license and patent rights east of the Mississippi from the Atlas Imperial Engine Co., of Oakland, Calif., for the manufacture and marketing of both the marine and stationary types of airless-injection Diesel oil-engines as developed on the Pacific Coast under the direction of A. Warenskjold, president, one of the first Americans to build a marine internal-combustion engine.

Considerable importance should be placed in this decision because the Bessemer Co. have an international reputation for the manufacture of horizontal-type oil engines and gas engines, their oil engine being of of the surface-ignition type. The Bessemer executives have realized that while their own engine is excellent in every way for certain types of work, particularly in the oil fields, it has certain limitations, including a limited market, which could only be overcome by the construction of a vertical engine oil-engine of the Diesel type.

Their new license calls for the construction east of the Mississippi of marine and stationary units of 50 b.h.p. to 1,000 b.h.p. *for the world's markets,* with the exception of the marine trade on the Pacific Coast. The Bessemer factory is particularly well equipped for quantity production, so deliveries of a high-grade engine at minimum cost can be expedited, over 1,000 men now working. Already on hand are orders for a total of 1,000 h.p. and the plant is rapidly getting into production and expects to make first deliveries between March 1st and 15th. Altogether 24 different sizes in three, four and six cylinder sets will be handled. O. D. Treiber, who for many months has been handling the Atlantic Coast sales for the Atlas-Imperial Co., and who came direct from the factory for this purpose, has joined the Bessemer organization.

Steamer Conversions and the Marine Congress

A report urging the Shipping Board to sell its idle vessels for conversion to Diesel-engine power and recommend that Congress authorizes the use of the Construction Loan Fund to aid shipowners and shipbuilders in making the change was adopted by the Diesel Engine Committee of the American Marine Congress. The committee states that the Construction Loan Fund now amounts to about $100,000,000. The recommendation of the Committee is as follows:

1. That this congress strongly indorses the advisability of fully utilizing our present opportunity of converting our less efficient steam vessels to vessels equipped with oil-engines.

2. That the United States Shipping Board be requested to have prepared and cause to be released as public information a report of the recent survey of its idle or other tonnage suitable for conversion into vessels equipped with oil engines and to include therein a fairly comprehensive statement of the physical condition of such vessels.

3. That the Construction Loan Fund established by the Merchant Marine Act of 1920 be made available for loans for the conversion of suitable Shipping Board steam vessels to motor vessels and for equipping them with such new auxiliaries as this conversion would necessitate.

4. That the government be encouraged to continue to sell such vessels for such conversion under the most advantageous terms to the purchaser.

5. That purchasers entering into agreement for such conversions shall be enabled to borrow from the fund named in paragraph three to an amount not exceeding two-thirds of the cost of complete conversion, under the same terms and conditions as now are provided for in case of new construction. Such costs of conversion to include shipyard charges for installation and necessary repairs and alterations to hull, as well as the costs of main engines and auxiliaries, the remaining one-third of all such costs to be borne by the purchasers.

Large Diesel Marine Engines Building to Lloyd's Supervision, June 30th, 1923

Total Horsepower	*Two-Cycle*	*Four-Cycle*	*Total*	*Average per engine*
246,000	92	83	175	1,405 h.p.

Sixty-three of these oil-engines are destined for single-screw ships. The two biggest of these engines are Burmeister & Wain, six-cylinder, four-cycle, double-acting, 33 in. dia. by 59 in. stroke developing 6,750 shaft h.p. each. Evidently this list does not include the six-cylinder, four-cycle 7,000 shaft h.p. North-Eastern-Werkspoor Diesel marine oil-engine since commenced construction at Wallsend, England.

Motorships Registered With Lloyd's, June 30th, 1923

	Number of Ships
Under 1,000 tons gross	1,161
Over 1,000 tons gross	335
1,000 to 1,500 tons gross	71
1,501 to 2,000 tons gross	52
2,001 to 4,000 tons gross	87
4,001 to 6,000 tons gross	65
Over 6,000 tons gross	60
Total	1,831

Eighty per cent. of the 264 vessels exceeding 1,500 tons gross are full-powered craft, the remaining 20 per cent. being auxiliary sailing ships. Forty-one motorships of 164,665 gross tons were built between July, 1922, and June, 1923.

The Krupp Diesel-engined motor yacht RIPPLE recently built for Clifford N. Leonard, of New York City, is now at Jacksonville, Fla., after having crossed the Atlantic under her own power in heavy weather.

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Spanish Motor Tanker *Arnus* on trials

Sea-Trial of Neptuned-Engined Tanker ARNUS

Direct or Diesel-Electric Drive for Propelling Merchant-Ships Discussed by Her Builders

IN referring to the fact that Swan, Hunter & Wigham Richardsons, Ltd., Wallsend-on-Tyne, have seven single-screw motorships under construction to have Neptune Diesel-engines with direct-drive, Technical Director C. F. Tweedy on the trials of the new motor tanker ARNUS, held recently in the North Sea, referred to his company having built in 1910 a Diesel-electric-driven ship with two 500 h.p. oil-engines on a single screw. Mr. Tweedy said he referred to this job because they have heard a great deal recently about the Diesel-electric system and that personally he was not in favor of it. Furthermore, he did not think the Diesel-electric system would be fitted in many merchant vessels because of the increased first cost and weight; also, the consumption was 10% to 12% higher. The Neptune engine in the ARNUS was running on fuel-oil of 0.94 degrees Beaumé, and during the shop tests had run 24 hours trial on that fuel.

Regarding the seven motor vessels on hand, one is of 3,200 h.p., four of 2,200 h.p. and two of 1,250 h.p. Five of these engines will have separate scavenging-pumps utilizing the working cylinders for maneuvering, while the others will have engines of the stepped-piston type with the scavenging cylinder below the working cylinder, using the lower cylinder for maneuvering. So far as reliability is concerned, Mr. Tweedy considers that the shipowner to-day could look at the Diesel engine, whether the two or four-cycle type, as a reliable unit. As far as auxiliaries are concerned, he favored oil-engine electric drive.

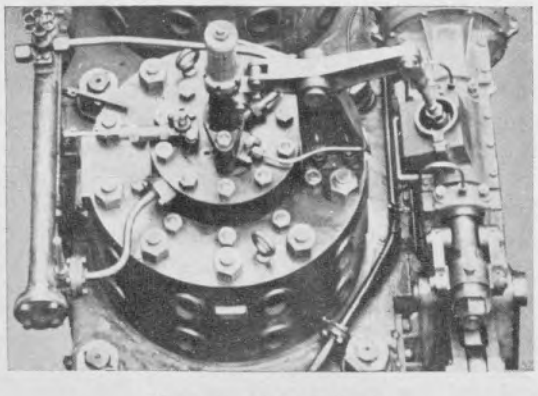
He did not take seriously the theory that it would be difficult to get efficient engineers, as suitable men would develop simultaneously with the Diesel engines. If qualified men with sea experience spend three or four months in the builder's works erecting and testing, they will be quite capable of running motorship engines.

Because two large cargo motorships are building at this British shipyard for the Mount Line, of New York, N. Y., the installation in the ARNUS and the results of the sea trials of the ARNUS should be of not a little interest in this country. When at Swan, Hunter & Wigham Richardson's last Fall we were enabled to see one of the twin Diesels of the ARNUS in operation on the test bed, and found many features of the design worthy of more than casual attention.

The ARNUS has been built to the order of the Compania General De Tabacos De Filipinas, Spain, which already owns the Armstrong-Sulzer powered motor-tanker CONDE DE CHURRUCA. Both vessels are alike as regards the hull and the engines of the earlier vessel are also of the two-cycle type. Both engine installations have already been described in MOTORSHIP.

Swan, Hunter & Wigham Richardsons were one of the very early firms of marine engineers to specialize on oil-engines. For instance, the Great Lakes freighter TOILER, built in 1910, and fitted with two 180 b.h.p. Neptune-Polar type engines, was the first large motor-vessel (1,550 tons gross) to cross the Atlantic. Other Diesel ships were completed just prior to the war, including the TYNEMOUNT, ARUM and ARABIS. Experiences gained in those early days of the motorship have been embodied in the first post-war model Diesel, of which two sets form the main propelling-plant of this new tanker.

The vessel measures 377 ft. by 49 ft. (extreme), by 28 ft. 9 in. moulded depth, and has a D.W. capacity of 6,400 tons on 23 ft. 3 in. draft. With a gross tonnage of 4,185 tons and a net tonnage of 2,548 tons, about 5,700 tons of oil cargo (49 cu. ft. per ton) are carried, and her bunkers hold 570 tons of oil-fuel (39 cu. ft. per ton).



Neptune cylinder head

A steel vessel built to the highest class in Lloyd's Register, she is fitted with fourteen cargo-tanks designed for handling both white and black oils in bulk. Summer tanks are provided and in addition there is a hold forward for carrying ordinary cargo. Oil-fuel bunkers are forward of the engine-room; the double bottom under the machinery space is available for oil fuel or water ballast; additional storage for ballast is provided in the fore and aft peaks. In addition a deep tank is situated in the ordinary cargo hold, and also arranged for oil-fuels, if desired. Two Weir oil-cargo pumps of about 250 tons per hour capacity each, housed in a pumproom amidships, aft of the bridge, are available for handling the cargo, and that selection together with the usual steam coiling of the cargo tanks necessitated the installation of a Howden oil-burning forced-draught boiler 10 ft. 6 in. diam. by 11 ft. 6 in. Steam will be available on entering and leaving port and whilst in port, hence a 55 k.w. Allen steam generating-set has been installed for use during that time.

This extensive use of steam also led to the decision to use steam for deck machinery, which includes one windlass and two winches. But as these take their supply from an oil-fired donkey-boiler fitted aft, it is not quite apparent to us that the most economical results will be secured. The steam auxiliaries are more numerous than is usually the case with oil-engined cargo boats, and include a 20-ton (24 hour) Weir evaporator, a 1,000 gallon (24 hour) Hocking distiller and an auxiliary condenser (600 sq. ft.) of the Neptune type.

When at sea the auxiliaries are electrically driven. Two 55 k. w. Sulzer oil-engine generating sets (250 volts) are arranged on a flat aft of the main engines, the engines being of their new two-cycle

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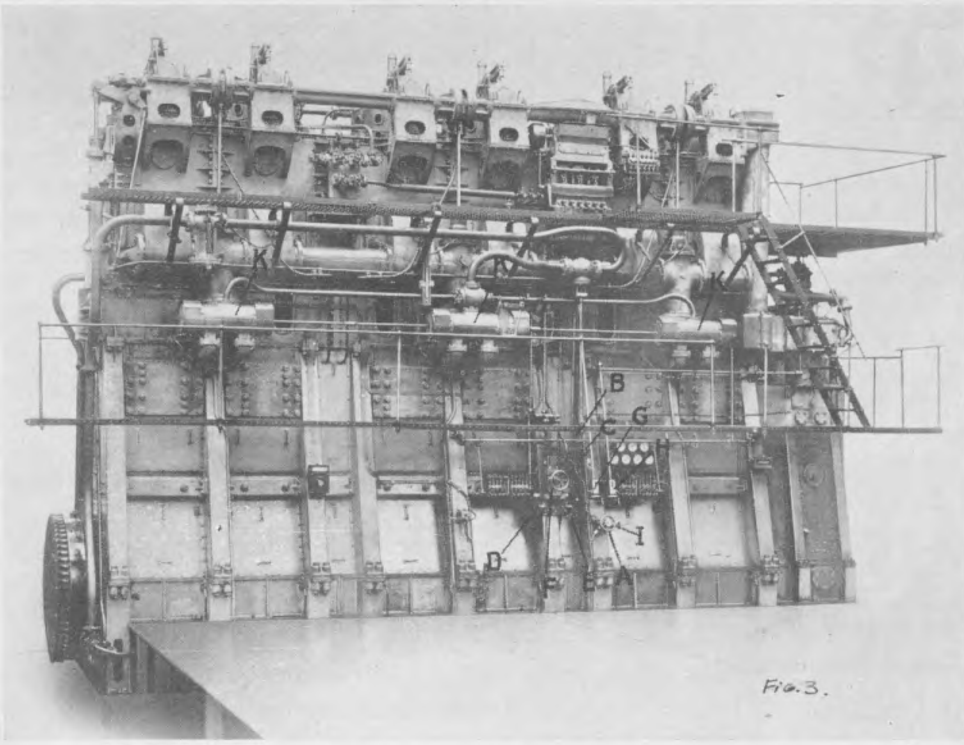

One of the twin 900 shaft h.p. Nepture engines of the *Arnus*

design only recently placed on the market by Sulzer-Freres, of Winterthur. These twin-cylinder sets have crank-case compression, hence are two-cycle, but use a much higher compression than is generally associated with this class of engine, in order that the engine may start up from cold with airless-injection of fuel. As with several American oil-engines, provision is made to insert a cartridge (tissue paper soaked in saltpeter) in the cylinder head after igniting the cartridge in case unfavorable atmosphere temperatures make a ready start difficult. The engine is of the Leissner type.

Apart from the two main air-compressors, of which one is fitted to each main engine and the scavenging pumps which form an integral part of the power piston, all auxiliary machinery is independently driven, and comprises:

One 100 ton per hour	Drysdale	centrifugal ballast pump.
One 30 ton per hour	Clarke Chapman.	bilge pump.
One do	do	general service pump.
Two 3,800 gals. per hour	Hayward-Tyler.	feed pumps.
One 110 ton per hour	Lamont	ballast pump.
Two 12 ton per hour	Rotoplunge	oil-fuel transfer pumps.
One (size not given)	Clarke Chapman.	oil-fuel pump.
Two 3,500 gals. per hour	Rotoplunge	lubricating oil pumps.
Two 10,000 gals. per hour	Drysdale	centrifugal piston cooling-water pumps.
Two 20,000 gals. per hour	Drysdale	centrifugal cylinder cooling-water pumps.

As regards emergency sets, they include one 12 k.w. Metropolitan-Vickers lighting generator-set, one 8 k.w. oil-engine driven (ordinary Sulzer surface-ignition type) emergency compressor generator and compressor combined in one unit producing 70 cu. ft. of free air compressed to 1,000 lbs. per sq. in. and two auxiliary Sulzer compressors (one electrically-driven, one steam-driven), supplying 90 cu. ft. of free air each compressed, if necessary, to 1 000 lbs. per sq. in. The steering gear is hydro-electric.

As will be remembered from the previous engine description the two main engine sets are both 900 shaft h. p., six-cylinder Neptune two-cycle Diesel engines with cylinder dimensions of 17 in. diam. by 35 in. stroke running at 112 r.p.m. The maximum designed speed of 125 r.p.m. can be maintained for lengthy periods, when the power developed by the two sets will be somewhat over 2,000 shaft h.p. or 2,600 i.h.p., giving a mechanical efficiency of about 77%. The scavenging cylinders are 21¼ in. diam., are, as already mentioned, situated immediately underneath the power cylinders, thus enabling the scavenging pistons to become the starting and maneuvering pistons. The only valve in the cylinder head, therefore, is the fuel valve which, as will be remembered, is not situated in the main cylinder head, but in a small inserted liner provided with rings where it meets the main cylinder head. By this arrangement it is free to expand under all working temperatures.

The speed, slow running, maneuvering and steering trials at sea proved entirely satisfactory and had the complete approval of the owners. With tankers it is comparatively easy to arrange for fully loaded conditions, and during a 9 hours trial a speed of 10¾ knots was maintained comfortably; a speed of over 11¼ knots was reached in ballast trim. Incidentally, it might be mentioned that the fuel-consumption at 10 knots loaded is not expected to exceed 7½ tons per day.

It was possible to slow down to 25 r.p.m. without the slightest trouble, and during a period the speed was as low as 20 r.p.m. (i.e. 16% of designed speed). Such a speed range of over 6 to 1 should suffice to meet the most stringent conditions in practice. Reversing from full-ahead to full-astern took seven seconds.

We will recapitulate the operations for reversing the Neptune engine. Turning to the engine illustration, A is the master valve for the injection-air, B is the master valve for the starting-air. Both are kept open during maneuvering operations. Lever C is for releasing the pressure in the cylinder and need not be interlocked because no damage can result if valves are kept open longer than necessary. Lever D controls the servo-motor which moves the camshaft horizontally to allow the respective set of cams to come into operation.

There are five notches on the lever quadrant to provide for full and half cam position of the fuel valves either ahead or astern, the reduced fuel-valve lift coming into play for slow speed. Lever E has also a dual function, first of all cutting off the scavenging suction-valve and then admitting compressed air from starting bottles to scavenging cylinders.

There are three change-over valves (K), one for each two cylinders, which are controlled by lever E, which is put back into its normal position as soon as the cylinders are firing. Wheel G controls the period of the opening of the suction valve of the fuel pumps, and thereby the speed, whereas wheel H controls the injection pressure to suit whatever load may be on the engine at the time. By-pass valve I permits any surplus injection-air to pass into the main starting bottles, hence the fullest use of the main compressors can be made from the very first revolution of the engine.

Once the engine is on the way, wheel F is used to lock levers D and E in their respective normal positions. The fuel-pump suction-valves are out of action during the actual reversing operation and are brought into action again automatically when the reversing has been completed. Fuel is, therefore, not delivered to the cylinder until the precise moment when positive ignition of each charge is assured.

Mexican fuel-oil of about 0.94 specific gravity of a similar composition to the detailed specifications published in MOTORSHIP, page 173, 1921, when discussing the Doxford engine trials on heavy fuel (about 18 degrees Beaumé) was used during lengthy periods of the trials and proved quite satisfactory with an injection pressure of 850 to 900 lb. per sq. in., equivalent to about 9-10 lb. on the L. P. stage and 85-100 lb. on the M. P. stage.

The cylinder cooling-water pressure was around 10 lb. per sq. in. against about 50 lb. per sq. in. for the piston.

Two of the Diesel engines now going through the Neptune plant are identical to those fitted in the M. V. ARNUS. With the five other and larger size engines, i.e. 2,000 b.h.p. and 3,000 b.h.p., they have changed the design, the scavenging pumps being worked by levers off the main engines instead of locating the pumps beneath.

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Motorship

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RUSSELL PALMER .... Manager

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1923 in the Oil-Engine Industry and the Outlook

LOOKING back over 1923 one is forcibly struck by the remarkable progress made in all branches of the oil-engine industry. Lloyd's figures show that in the face of the greatest steamship building slump motorship construction has shown a steady gain for the twelve months; in fact, oil-engine tonnage has more than doubled since the end of the War. Some very large land oil-engine orders have helped the American industry this year, one pipe-line job being for 76 sets aggregating 34,430 horsepower with a value of over $2,500,000. Aside from the fact that even with one month yet to go there has been a record number of marine and stationary oil engines ordered or delivered in the United States, splendid progress has been made with design. The small oil engine has advanced to an unanticipated degree and now nears its big brother in consumption and grade of fuel burned. Today the average low-powered oil engine in this country is considerably ahead of European motors in design and methods of construction, due in part to abandonment of blow-torches for starting, to increased cylinder pressures and to concentration on development of airless injection, as well as the production of a simple type intermediate of the Ackroyd and true Diesel cycles. The excellent stage to which the domestic oil engine up to 500 h.p. has reached (combined with steadily-improving business and the widespread call for economy) has not been without its effect, resulting in most extensive adoption for tugs, ferries, fishing-boats, yachts, canal craft and other classes of work-boats, all indications being for even greater sales in 1924. Particularly in the tow-boat field has there been a marked leaning towards oil-engine power. A miniature boom has started which looks like turning into a real boom.

Several American oil-engine builders have been running two shifts of men per day while for months three 8-hour shifts have been run by the Company that has the World's greatest output of units from 25 to 300 h.p. Today their quantity production makes them a competitive factor everywhere, even in England where oil-engine prices, generally speaking, are not more than 60% of average American construction costs. In the face of good business one or two domestic builders have "gone to the wall" during the past year, partly through failure to bring their products in line with today's advancement, although one concern went into the receiver's hands while possessing a record order list because of the failure of the parent company which was engaged in another industry.

In the large marine oil-engine field American manufacturers and shipbuilders have done much towards advancement, but have received practically no encouragement from the private shipping interests or from the Shipping Board, although shipowners stand to receive the greatest benefit. Consequently, Europe has made greater strides during 1923 both numerically and in very high powers. America's biggest engines are below 3,500 h.p., whereas Europe has started to build single and double-acting Diesel ships of 12,000 to 16,000 h.p. as for passenger motorliners, of which four are of 18,000 to 22,000 gross tons.

The year is notable for other important motorship developments. Great Lakes ore-carriers and ocean ore-carriers of the largest size have been ordered, the largest tankers, the largest yachts, the largest dredges, the largest fruit-carriers and the largest tugs have been laid down, all with oil engines. Results of these vessels will be watched very closely as they undoubtedly will have great influence upon the future of the World's merchant marine. Technically, some distinct departures have been made in the period under discussion. America has developed the Diesel-electric drive in a most extensive way, over fifteen ships of this type up to 3,000 h.p. each having been ordered or completed in the States, or else largely through American enterprise in Europe. America, too, has taken the reduction gear and rendered it practical for merchant ships, and Germany simultaneously has shown that reduction gears can be used commercially and successfully with high-speed Diesels. This opens up a new track. Then again, our engineers—aside from producing some excellent "strictly American" big oil engines—have acquired some of the best foreign designs and modified them to the extent of marked improvements. Germany has released this year, through the medium of this magazine, the story of how she constructed during the War a Diesel engine of 12,000 to 17,000 h.p., which is of greater power than any of our shipowners believed possible, now or in the future.

Conversion of steamers has made much headway, about a dozen U. S. vessels having been changed during the year from steam machinery of different types to Diesel power, although this has been due principally to the foresight and enterprise of shipbuilders and not to the credit of our shipowners. The latter, unless they wake up, will find themselves unable to compete against foreign fleets. If Congress facilitates financial assistance and if the Board settles upon a definite policy about thirty or more steamers will be converted in 1924. Interest in oil engines has increased in coastwise and in Great Lakes and other inland waterway shipping; there are splendid possibilities for marketing oil engines in these fields in the coming year. Unless something radically detrimental occurs to business conditions in this country, the next twelve months will produce a bumper oil-engine crop. MOTORSHIP and its companion journal, OIL ENGINE POWER, are sowing the seeds. The manufacturer must provide the fertilizer and stimulate the growth with adequate publicity assistance. Then our readers will be ready to purchase the crop and none of it will be left in storage. At last the oil engine is receiving proper recognition in all quarters and is rapidly coming into its own. Such a fundamental economy can be retarded, but not held back indefinitely.

Killing the Goose!

LAST month we commented on a paper read by the chief engineer of a well-known East Coast shipyard in which he inferred that in practically all cases from 1,000 to 4,000 h.p. steam machinery has the economic advantage over the oil engine for merchant ships, excepting a double-acting two-cycle Diesel, which incidentally would only be beneficial up to 4,000 h.p. Unless this is intended to form a subtle method

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of preparing the way for the marketing of a new double-acting two-cycle oil engine, such a claim certainly tends to kill the goose that lays the golden eggs. For, at the present time, the country is overburdened with steamships which cannot be operated at a profit and which are now rusting at their moorings, and the only hope of providing plenty of work for our yards is the conversion of a fleet of these useless craft. Every man is entitled to his own reasoning and to free speech on the same, but all those connected with shipyards should do their utmost to convince shipowners of the benefits to be derived from Diesel power, and not throw a monkey-wrench in the cog wheels by presenting theoretical figures contradictory to established facts. Because the confusion consequently arising tends to prevent shipowners buying steamers from the Board and employing the shipyards to convert them. Let's keep the goose alive!

The Fuel-Oil Question

ON a number of occasions endeavors have been made to scare shipowners from adopting Diesel power, on the grounds that if a large number of vessels were motor-driven the price of oil might be forced up in a few years to the extent of making the Diesel engine an unprofitable investment. In a similar maner the old scare of oil shortage has also been the war cry of those who have everything to lose and little to gain by the adoption of Diesel power, such as the turbine, steam-boiler and coal interests, who see trade slowly slipping through their hands in the march of engineering progress and economy.

Oil companies are not foolish, and when the motorship's numerical supremacy time comes they will not destroy the market for their product by increasing its price to a figure whereby all motorships would have to be laid up and only coal burners operated. Oil companies do not make any profit on the sale of coal and, naturally, wish to encourage types of propulsion which would ensure them of a steady market for their fuel supply. We must get the utmost power out of every drop of oil, hence oil-fired steamships should not be encouraged because of their wasteful consumption of oil, also because if coal ever drops to the pre-war figure, it will be uneconomical to run *steamers* on oil fuel unless the oil companies market the same at a price which robs themselves of all profit. Even to-day several oil companies are no longer anxious to sell more than a limited quantity of heavy-oil for bunkering purposes as the lower price of coal creates a depressed market price for oil that is unattractive. But coal can never be brought to a sufficiently low figure to allow of competition with fuel-oil consumed in Diesel engines. There is too vast a difference in the consumption per horsepower.

The best efficient of coal-burning freighters is 1.25 lbs. per i.h.p. hour and generally nearer 1.5 lbs. in actual practice; whereas the oil consumption of a modern motorship never exceeds 0.35 lb. i.h.p. hour and generally is 0.30 lb., or a little less under ordinary sea-going conditions. The best oil-fired steam practice is 0.85 lb., but often is 1.00 lb. per i.h.p. or over. At the present time Diesel oil can be purchased in California for $0.90 per barrel, or $5.60 per ton, compared with $19.25 per barrel in Great Britain, offering a distinct advantage to American motorships, as the European vessel must first cross the Atlantic to secure low-priced fuel for return voyages if engaged in the Atlantic, Panama Canal, West Coast and Far East trade. Readers may have noticed in the daily press that for her western voyages the LEVIATHAN bunkers about 4,500 tons of oil at Southampton, England. This means that in order to supply fuel for the return voyage of this great ship a 10,000 tons tanker has to be kept in steady employment. Hence, to the ordinary cost of operating the LEVIATHAN must be added the overhead and operation of a million-dollar tanker. If the LEVIATHAN was a Diesel-driven ship she would need less than 3,000 tons of oil for her round trip, so would not be burdened by the cost of tanker transportation of fuel to England, as her double-bottom could carry more than the necessary quantity.

Big Motor-Liner Proposed for Australian Service

Sir John Biles, the well-known British naval architect, has proposed that the British and Australian governments shall subsidize a two-weekly service between England and Australia, to be maintained by a fleet of six 700-ft. motor-liners, each carrying 400 cabin passengers and 2,000 steerage, as well as 1,000 tons of cargo, the subsidy to be £75,000 per annum per ship, or a total of £450,000. The proposal is based on the assumption that it is now possible to install Diesel engines totalling 27,000 h.p. per ship on three propeller shafts, which will give a speed of 20 knots. This will enable mails to land at Fremantle within 19 days after dispatch from London. It is proposed to employ one ship for two trips only during the year, using her for the balance for special cruises. But if she was idle and not used on cruises her subsidy would have to be £120,000.

Tankers For Anglo-Saxon Co.

The five 2,300 D.W. tankers recently ordered by the Anglo-Saxon Petroleum Co are to be steam-driven, although alternative proposals for oil-engines were requested. Final choice was entirely due to the relative first cost of oil-engines and steam, and because the owners required a certain amount of steam for heating heavy oil cargo. Obviously, it is important that oil-engine builders make a more extensive study of the use of exhaust gases from the main oil-engine, as well as the heat and circulation water for producing steam.

Two More Double-Acting Diesel Engines

It is reported that the Stoomvaart Maatschappij Nederland, who recently ordered the conversion of one of their turbine-driven freighters to Diesel power, are contemplating the construction of a cargo ship of approximately the same size. In all probability the new Werkspoor double-acting Diesel engine will be installed. What is of equal interest is that the same ship-owning company are considering ordering a Diesel-driven passenger liner before the end of the year.

Single-Screw Tanker of 3,200 I.H.P.

In our description of the ARNUS we referred to an 8-cylinder, 24 in. by 50 in. two-cycle Neptune engine of 3,200 i.h.p. at 90 r.p.m. for a single-screw vessel. The keel of this ship has been laid and she is a tanker to the order of British Tankers, Ltd. There will be separate scavenging pumps driven by rocking-levers. This necessitates changing the head of the working-cylinder to the extent of fitting an air-starting valve alongside the fuel-valve. This modified scavenging arrangement will allow of a much simpler construction of the piston. The telescopic cooling-rods to the pistons will be arranged to fall within the cylinder diameter and the crown of the piston will be arranged for controlled directional flow of the cooling-water at high velocity and pressure to prevent formation of deposit.

New North Eastern-Werkspoor Engined Motorship

Particulars of the motor-vessel ordered not long ago by James Chambers & Co., of Liverpool, England, and which will be the first motorship of this firm's fleet, have now been published. She will be 400 ft. in length b.p., 52 ft. 3 in. moulded breadth and 37 ft. 6 in. in moulded depth measured to the shelter deck, propelled by a single eight-cylinder 2,500 shaft h.p. North Eastern-Werkspoor engine with cylinders 28¾ in. by 51¼ in., which will give her a surplus of power for the designed sea speed of 11 knots in average weather. Three Diesel-engine generator-sets will be installed as auxiliaries, two of which will be of 100 k.w. capacity and the third of 75 k. w.

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Motorship SUPHENCO and Her Craig Engine

(*Continued from page 789*)

Details of This Interesting Installation Continued From Our November Number

Part II

ALL the deck machinery, namely the winches, windlass and steering gear, as well as the engine-room pumps and auxiliaries are operated by electricity with specially designed Edco motors supplied by the Electro Dynamic Co., of Bayonne. The only steam on the ship is a donkey-boiler for heating the accommodation and fuel-oil. To furnish this power there are three auxiliary Diesels in the engine-room, one of these is a Craig four-cylinder 16 in. bore by 18 in. stroke engine of 250 b.h.p. at 250 r.p.m., and between the two pairs of cylinders there is an air-compressor of large capacity, sufficient to supply blast-air to operate the main engine.

There also are two Craig twin-cylinder 16 in. by 18 in. Diesels of the four-cycle type developing 150 b.h.p. each, direct connected to Edco 85 K.W. generators. They are equipped with oversized air-compressors for supplying emergency injection-air to run the main engine at reduced power, should the main compressor-set be out of action. In addition there is a four-cylinder gasolene-driven compressor-set for emergency purposes, this set being started by hand. Direct connected to this gasolene engine there is a 10 K.W. generator to serve for lighting purposes when the ship is in port.

The pump equipment consists of the following:

Two Worthington 6″ centrifugal main circulating pumps
One Worthington 6″ x 12″ duplex double-acting fire and bilge pump
One Worthington 10″ x 12″ duplex double-acting ballast pump
One Worthington 5″ x 6″ duplex double-acting fuel-oil transfer pump
One Worthington 2½″ centrifugal sanitary pump
One Worthington 1″ centrifugal scuttle-butt pump
One Worthington 1″ centrifugal fresh-water pump
One 1¼″ gear-driven Rumsey pump for lubricating oil
One 1¼″ gear-driven Rumsey pump for draining settling tanks.

All above pumps are driven by Electro Dynamic Company's motors of various powers.

In addition to above there are three Gould's double-acting hand pumps serving as hand-fire pumps and extra fuel-oil transfer and lubricating-oil pumps. The refrigeration of the ship's ice-boxes is taken care of by a one-ton motor driven Brunswick compressor operating a direct expansion ammonia system.

On deck there are ten Lidgerwood electric winches, one electric capstan of the American Engineering Company's make, an electric windlass and electric steering engine also supplied by the same firm. All are driven by Edco motors, while the electric control devices throughout the ship are of Cutler-Hammer construction. The Lidgerwood winches are of the single-drum type. Half of the winches are arranged right hand and half left hand, a pair of winches being located at each hatch. The drums are 16 in. diameter by 20 in. face. Each winch has a single winchhead 14 in. diameter by 14 in. length. The frame of the winch is made of cast-iron, in one piece. There is a double gear reduction; the motor gears have cut teeth and the drum gearing has cast teeth. All gears are of cast-iron with the exception of the motor pinion, which is forged steel. The gearing is all grouped on one side of the winch and is entirely enclosed in a cast-iron gear casing. The lower half of this casing forms one side frame of the winch structure. The upper half of the casing is of cast-iron and is bolted to the lower half.

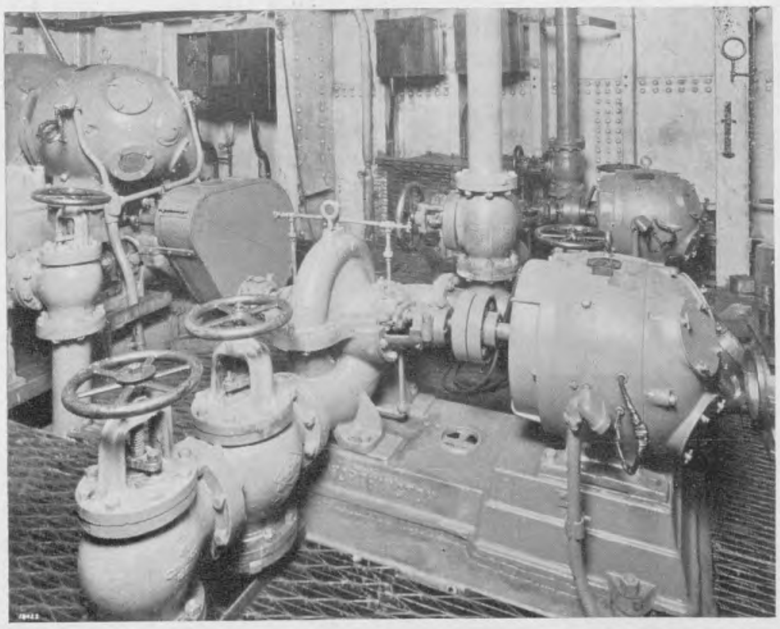
It is believed that this form of frame construction is unique for this type of machine. It confines the elements of the machine to very compact dimensions, which is a desirable feature for the ship's deck machinery. The shaft bearings are fitted with removable bronze boxes. All the main shaft bearings are provided with hinged cover oil wells suitable for packing with waste or hair. A hinged cover on the top of the gear casing provides means for lubricating the gearing.

The electric motor was supplied by the Electro Dynamic Co., and is rated at 25 horsepower, at 550 r.p.m. It is the ball bearing type and is watertight. The solenoid brake on the motor shaft was supplied by the Cutler-Hammer Mfg. Co., which company also supplied the control equipment comprising a watertight drum type controller arranged for dynamic braking lowering. The resistance was also supplied by the Cutler-Hammer Co. and is mounted on a waterproof box located on the deck. The winch is controlled entirely by the controller handle. A non-burn lined band brake operated by a foot lever is provided on the drum for emergency purposes.

This winch is geared for a hoisting duty of 4,000 lbs. at 170 feet a minute on the 25 horsepower rating of the motor. However, the series characteristics of the motor will permit handling the average load, about 1,800 lbs., at a rope speed of 225 ft. a minute, and will also handle drafts up to 7,500 lbs. at reduced speeds corresponding to an overload of the motor. The weight of the winch complete with motor and solenoid brake, exclusive of control, is approximately 6,000 lbs.

(*Finis*)

Three papers on motorship machinery subjects were read before the Institution of Engineers & Shipbuilders in Scotland during the meeting held from 16th to 30th Oct.



M.S. *Suphenco*—Showing some of the pumps driven by Electro Dynamic motors

M.S. *Suphenco*—One of the Lidgerwood winches with Electro Dynamic motors

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The Big Bethlehem Diesel Engine

Complete Description of This interesting 3,500 I.H.P., Two-Cycle Design, Will Appear in an Early Issue of This Magazine

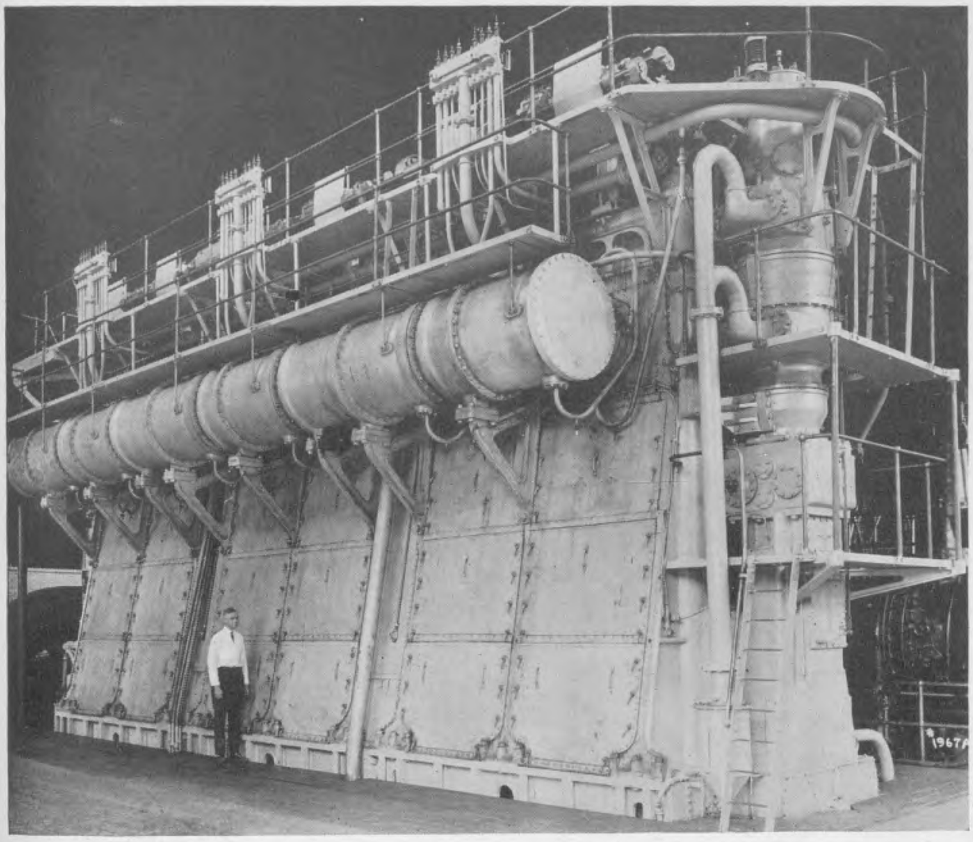
FOR several years the industry has been awaiting with considerable interest release of the information regarding the design and construction of the West Diesel engine, which was known to be under construction for marine and stationary purposes at one of the plants of the Bethlehem Steel Company, especially as it has leaked out that there were many novel features of construction embodied therein.

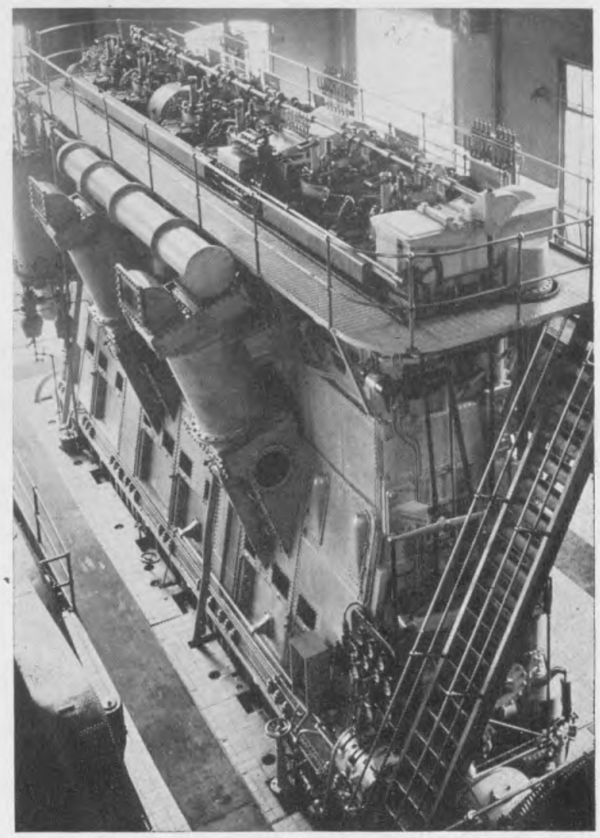
It is the policy of the Bethlehem Steel Co., however, not to place anything on the market until it has been thoroughly tried out under practical working conditions, on the basis that they prefer to bear the burden of development work rather than imposing it upon the purchaser. Consequently, all work done up to the present day has been considered purely as private experimental work and the engine has not been offered for sale.

The first Diesel engine constructed, namely, a six-cylinder, two-cycle set of 3,500 i.h.p., or 2,500 shaft h.p., was installed in the ore-carrier CUBORE, owned by a subsidiary of the Bethlehem Co., for the purpose of working-out and eliminating all weaknesses in design. After a few years' operation the engine was modified in minor details as the result of experiences gained, but has been found unnecessary to depart from the basic features of the design.

The second engine, of the same size, was built for their own power plant purposes in order that the engine could be developed for marketing in the stationary field. This engine has now completed over 28,000,000 revolutions under the varying conditions of shop load at Bethlehem.

The Bethlehem Steel Co. feel that they have now got an absolutely satisfactory product with all the "kinks" completely ironed out, and commencing with the new year will push the sale of this engine in both the marine and stationary markets. For demonstration purposes the stationary engine at Bethlehem has been equipped with a reversing gear. On November 22nd a number of engineers, shipowners and shipbuilders were invited to witness the engine in operation. Through the courtesy of the Bethlehem Steel Corporation represented by Arthur West, Manager, Power Engineering & Sales, Bethlehem Steel Co., and A. B. Homer, Diesel Engr., Bethlehem Shipbuilding Corp., we were enabled to inspect the engine a week prior of the more public visit. Arrangements were made for the complete technical and illustrated description to be published in an early issue.





First illustrations to be published of the Bethlehem-West 3,500 i.h.p. Diesel engine. It already has run over 28,000,000 revolutions under load, or the equivalent of 50,000 sea miles. Our reproductions show the exhaust and scavenging sides respectively. A complete description will shortly be given

Diesel-Electric Dredge TEXAS—Costs But $150 Per Day to Operate

There was recently placed in service on the drainage canal at Longview, Wash., the Diesel electric-operated dredge TEXAS, constructed by the Long Bell Lumber Co. from designs by and under supervision of James H. Polhemus, general manager of the port of Portland, Oregon. We give an illustration showing the TEXAS operating in a sand and clay formation digging to a depth of 6 ft. and pumping the material through 4,000 ft. of pipeline to an elevation of 15 ft. above the water level.

The electrical machinery of this dredge is driven by Pacific-Werkspoor Diesel engine. The vessel and her machinery has proved an entire success, having come up to every expectation. Efficiency is high and the operating costs are very low, due to the small amount of fuel burned and the small crew necessary for her operation.

Long Bell Lumber Co.'s dredge *Texas*, powered with a Pacific-Werkspoor Diesel engine

Under the above operating conditions the dredge is handling up to 6,000 yards per 24-hour day, getting in an average pumping time of about 22 hours per day, at a flat operating cost of approximately $150 per day. A total crew of 21 men operate this dredge three 8-hour shifts a day with a reserve crew for making the necessary repairs and pump alterations on Sundays. The fuel-consumption is 13 bbls. of ordinary bunker fuel-oil per day. The machinery is in charge of Chief Engineer Jackson.

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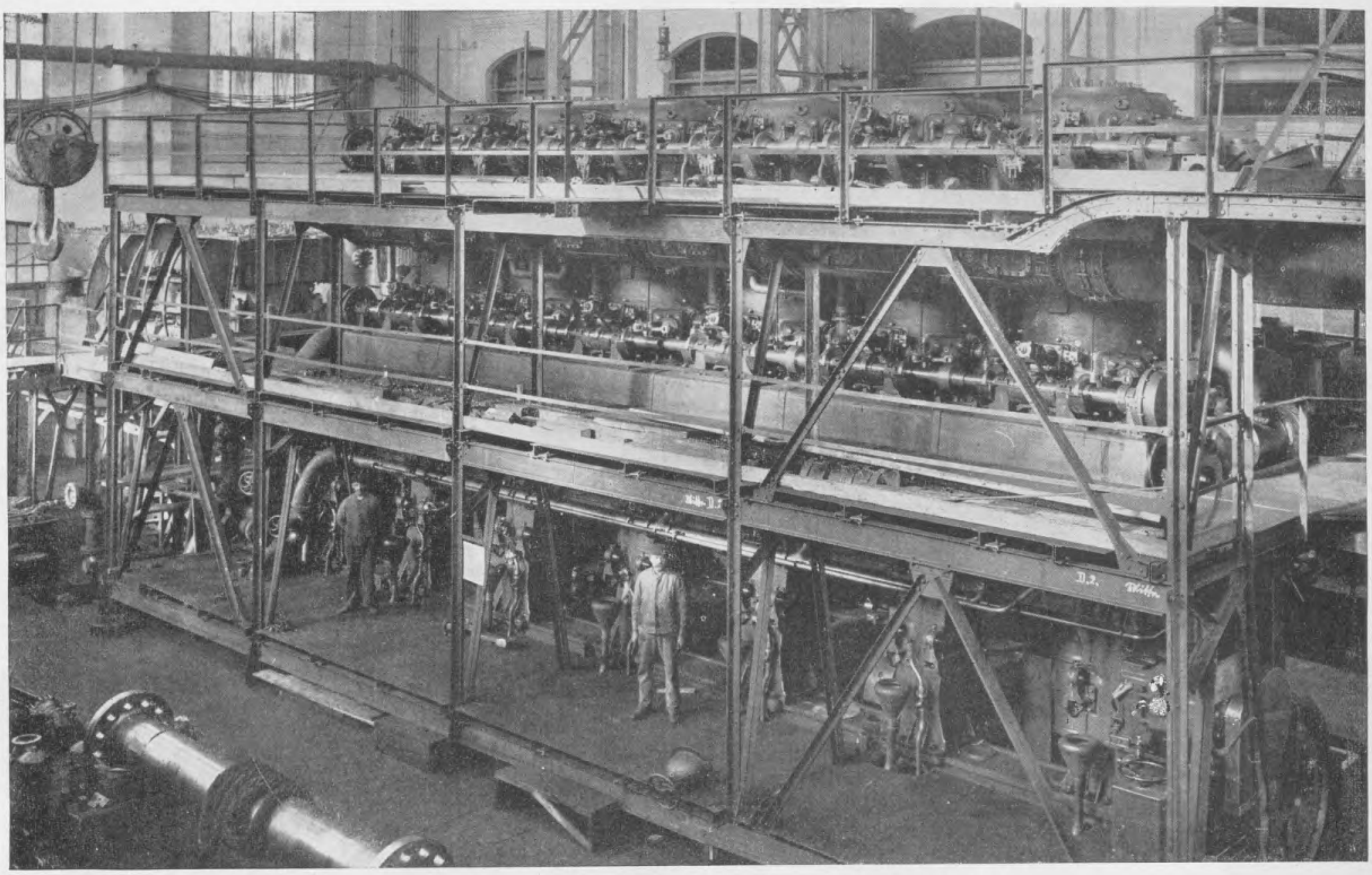

The final engine. On test it developed a maximum of 17,150 shaft h.p.

How the World's Largest Diesel Was Built

Special Story Relating How the Problems of Constructing a Marine Engine Which Developed Over 17,000 Shaft H.P. Were Overcome

By FREDERICK ENGLERT
Chief-Engineer, Nürnberg Plant of M. A. N.

The International Importance of this magazine has caused details of this valuable German oil-engine development work to be released to the English-speaking nations through its editorial pages. It has taken four years constant urging on our part to secure the consent. Mr. Englert in this story relates all the most serious problems which faced the M. A. N.'s engineers in bringing to a practical stage the highest-powered Diesel engine ever constructed—a truly formidable task. It forms the most advanced step towards a motor LEVIATHAN yet made. It is America's duty to carry on this progressive task and build a bigger oil engine. We have the money and our Engineers can do it!—*The Editor.*

BEFORE the war very keen attention was given in Germany to the problem of ship propulsion by oil-engines, and quite a number of manufacturers attempted to solve it by introducing a variety of designs. Before anything approaching a final solution could be found the war broke out, forcing all the Diesel builders to concentrate upon building of engines for submarines and aeroplanes. It is history today in which splendid way the engineering problem of the submarine engine was solved, and how it proved once and for all the reliability of the most sensitive type of oil-engine under the most trying conditions at sea. It is also common knowledge that on the side of the Allies the progress in the line of high power during that period was not as satisfactory, increased output being nearly exclusively obtained by simply increasing the number of working cylinders of relatively small dimensions. On the other hand, a tremendous development took place in neutral countries, especially Holland and Denmark, where the oil-engine for merchant marine purposes was brought up to a remarkable stage of development. These countries preferred mostly the four-cycle Diesel engine.

The question whether the four-cycle or the two-cycle engine is to be preferred is still an open one, but it seems that the four-cycle engine will be most adopted for the small and medium cylinder outputs, whereas the two-cycle engine will become prominent in the field of the big and maximum outputs. It is not possible to draw a distinctive line between the two because due to the progress which is made incessantly on both sides always one or the other type seems to offer more advantages.

One fact stands out, though, and that is the great progress made in scavenging and super-charging the two-cycle cylinder. This progress has been so marked that this type of engine now approaches very much the mechanical efficiency and the fuel and lubricating-oil consumptions of the four-cycle type engine. Considering these facts the inherent advantages of the two-cycle engine become more important, at the same time the serious objection against it more weighty, i. e., that its temperatures might become destructive.

It is my intention to show that and how it has become possible to control the heat stresses in the two-cycle engine which have been making this engine for a long time a very difficult problem.

As early as 1910 the question of developing a Diesel engine of large output was taken up at the Nürnberg shops of the Maschinenfabrik Augsburg Nürnberg and an experimental engine actually commenced. The cylinders of this engine were to develop 2,000 brake h.p. and were to work on the double-acting two-cycle principle. At that time the Diesel engine could look back at a development of 12 years.

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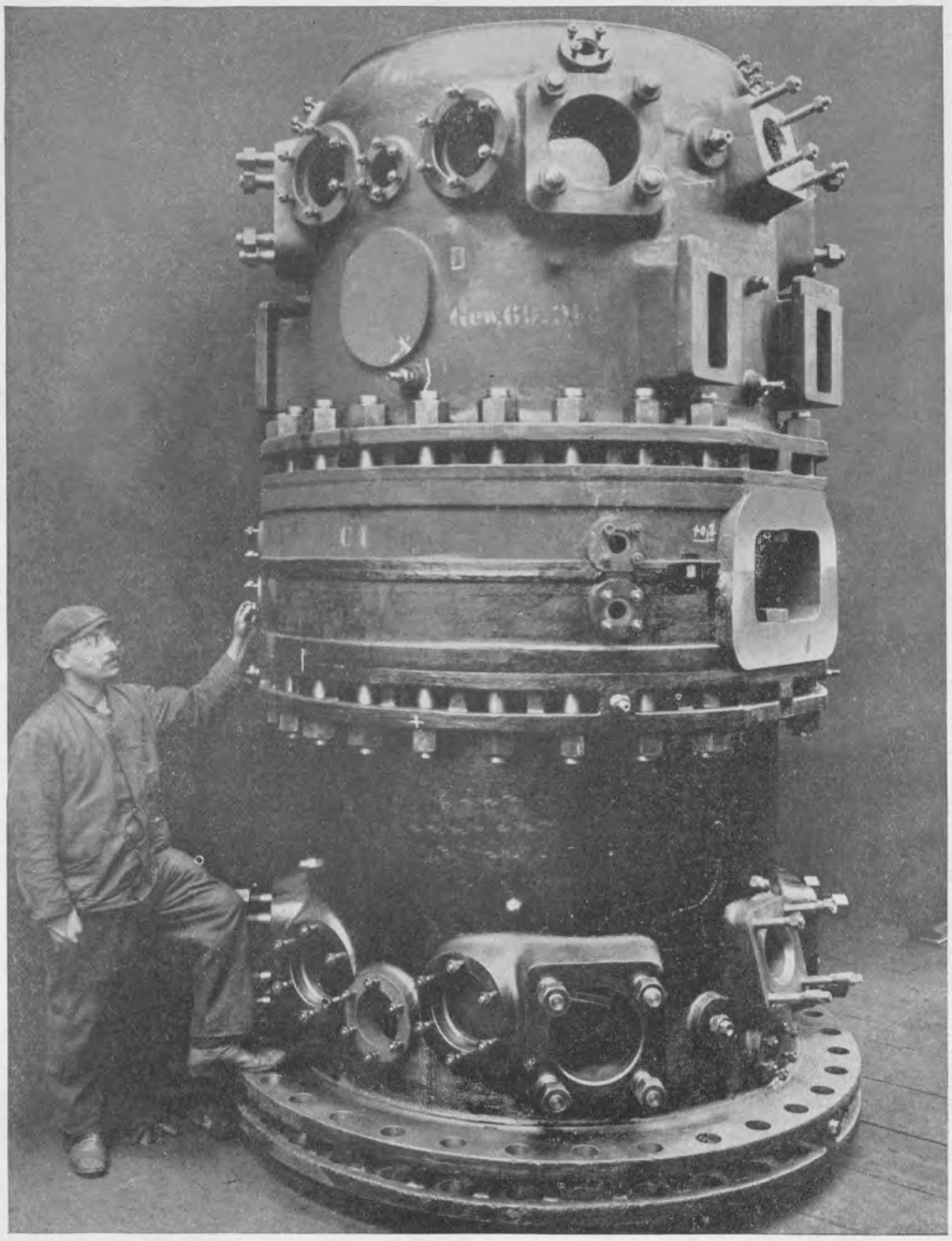
Although relatively big cylinder outputs supplanted the first small sizes, the most powerful engine at that time developed only 1,000 indicated h.p. in six cylinders. Thus in one step the output was to be increased from 170 i.h.p. to 2,600 i.h.p. But the M. A. N. engineers, in basing their designs on the experiences gained with the large gas engine during a development of 10 years, thought that the problem could be solved. This gas engine had shown the way to design the running gear so as to withstand the tremendous piston thrusts, and after a hard struggle, which for quite a while seemed to doom the double-acting cylinder, finally stuffing-boxes had been developed which were entirely reliable. So the actual Diesel problems seemed to be confined to the design of the liners, heads and pistons. The anticipated troubles on these parts have not failed to appear in great numbers, and it has taken long years of hard toil to overcome them.

The temperatures of the Diesel cycle vary between limits of 45° to 1,800° centigrade. A considerable amount of the heat introduced into the cycle—on the average about one-third—has to be conducted through the walls of the liner, the head and the piston into the cooling water. All other conditions being alike, the temperature drop necessary to conduct the heat through the walls depends upon their thickness and with cylinders of different diameters also upon the size of the heat-conducting surfaces. The result of temperature differences are stress differences of the fibres at the inside and the outside of the walls.

An example may show their magnitude. The temperature of the heated surface in a concrete case was 300° Cent., that of the cooled surface 150° Cent., so that the hot face was subject to a compression and the cooled face to a tensile stress of about 825 kg/cm². To these stresses have been added those due to the gas pressure, which, according to the design, may produce both axial and tangential strain. The first at least should be eliminated by the design of the parts, but at all events stresses from 1,100 to 1,300 kg/cm² are to be found often, and they can increase considerably at places where the free expansion due to the heat is in any way hindered.

The first experimental engine built at Nürnberg consisted of three cylinders of 850 mm. (33.46″) diameter and 1,050 mm. (41.33″) stroke. It was expected that 2,000 b.h.p. per cylinder could be developed at 150 r.p.m. Soon after starting this engine there appeared cracks in the heads and the liners, and it was quite impossible at first to stop them, although the design was changed and different materials selected. One series of cracks appeared at the pockets of the combustion space, another series in the bars between the exhaust ports. It was not difficult to explain these latter ones as being due to the design of the liner which was cast in one piece with the cooling jacket. In operation the liner became hot, whereas the jacket walls stayed cold. The expansion of the liner was thus hindered and a compression stress exceeding the elastic limit of the material set up. These cracks were easily avoided by subdividing the liner in the stays to permit free expansion lengthwise.



This 33½″ diameter cylinder gives a good idea of the size of the M. A. N., 12,000-17,000 h.p. marine Diesel engine. As high as 3,220 shaft h.p. has been developed by one cylinder at 145 R.P.M., or a mechanical efficiency of 90%

This first attempt to overcome this trouble followed thus one of the two possibilities that the designer has at his disposal to obviate the troubles inherent to the two-cycle design: one is appropriate design and the other is the use of appropriate materials. During continued experimental work extending over seven years the solution of the liner trouble was finally found in the first possibility, i. e., in an appropriate design, and it may be said right here that the engine as finally developed was actually built up of materials which could be procured from any good foundry or steel works.

The experimental work was carried on without interruption until January, 1912, when an explosion in the scavenge-air pipe temporarily held up the work. The story of this accident has been related in MOTORSHIP. Up to this time the maximum load obtained had been 5,300 b.h.p. It will be recalled that an investigation of this explosion showed that oil which had been accumulating in the scavenge pipe had, by an untoward coincidence, taken fire and had started a destructive conflagration. Since a very careful investigation of the accident disclosed that it was in no way due to the engine proper the experimental work was taken up again, and now an entirely new design of the cylinder begun. In the old engine the fuel-injection and scavenge valves were located in pockets of the covers.

This design was abandoned, and thereafter these valves were placed in recesses of the cylinder just like in the Nürnberg gas engine. The upper cover contained only the starting-air and safety valves, the lower nothing but a safety valve. Thus, the starting was effected by using exclusively the upper cylinder ends, and the first fuel injections were given on the lower ends, which are not cooled by starting air. Each end was equipped with four scavenge valves and two fuel-injection valves, the latter being located diametrically and on the sides of the engines, set at an angle.

(*To be continued in our January issue*)

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Launch of the Diesel-electric dredge *A. Mackenzie*

Two 3,000 H. P. Diesel-Electric Dredges Launched

Epoch-Making Vessels Enter the Water at the Sun Shipyard. Building for the U. S. War Department

TWO of the four large motor hopper-dredges now under construction at the Sun Shipyard, Chester, for the U. S. War Department, namely the A. MACKENZIE and W. L. MARSHALL, were launched on Nov. 20th and are expected to be in operation in January and February next. The other two dredges, the DAN C. KINGMAN and the WILLIAM T. RUSSELL are due to be launched in March and April next.

Drawings and a description of these dredges were given on pages 516 and 517 of our July 1922 issue. In each of these dredges there are three McIntosh & Seymour 1,000 b.h.p. 6-cylinder, 4-cycle crosshead-type engines. Each engine is connected to a 700 K.W. 500 volt Westinghouse electric generator. The vessels are twin-screw and 800 shaft h.p. motor at 90 to 110 r.p.m. being coupled direct to the propeller shaft. The third Diesel engine and electric generator is for operating a centrifugal pump. The dimensions of the vessels are as follows:

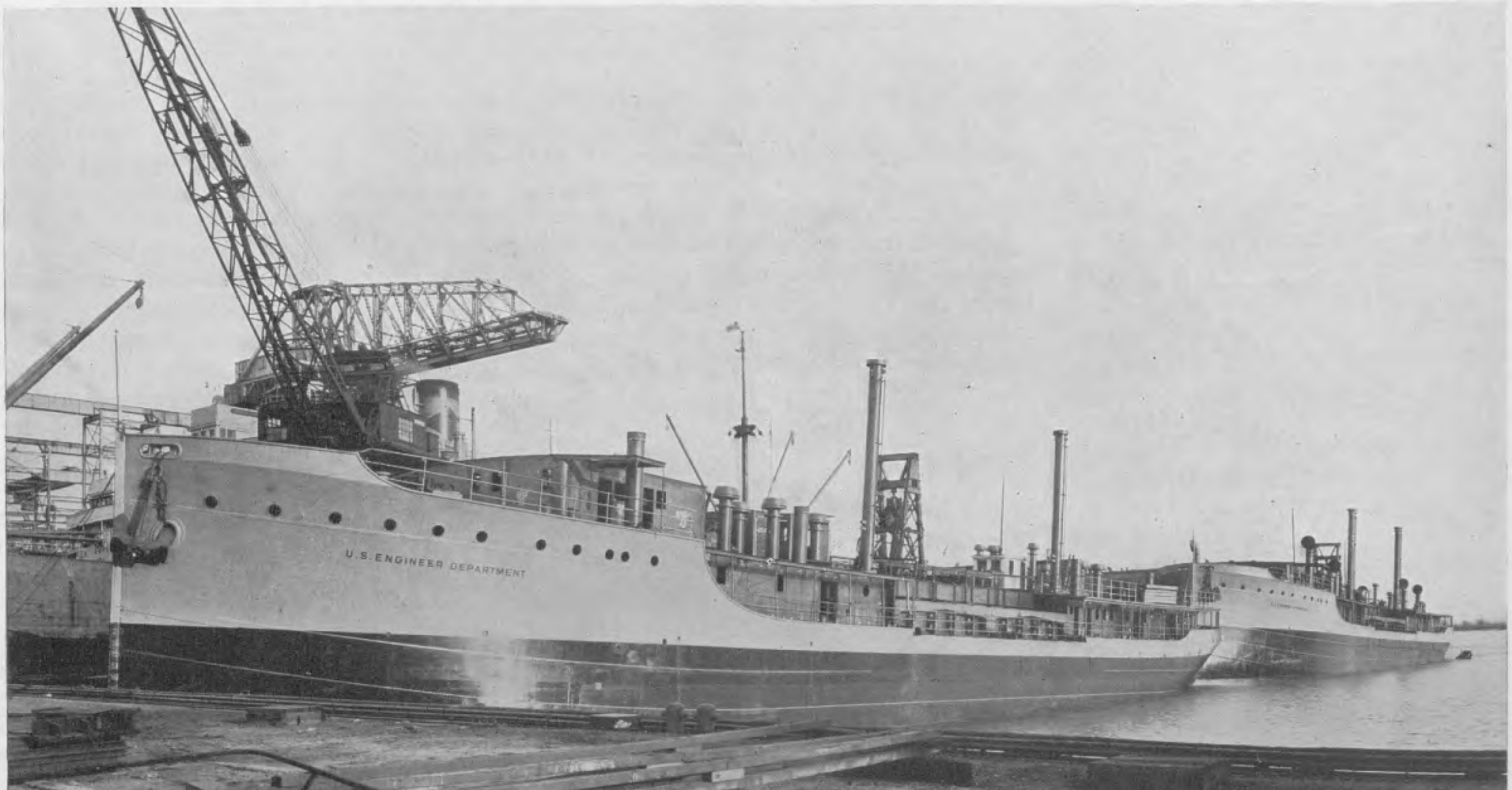
Length overall	268′ 5″
Length b.p.	254′ 0″
Beam	46′ 0″
Depth	22′ 6″
Draft loaded	19′ 6″
Draft light	12′ 0″
Capacity	1,250 cu. yds. of dredge material

A fifth dredge—of the pipeline class—is being constructed at another yard and with McIntosh & Seymour Diesel engines.

Every detail of these dredges has been designed by the Engineer Corps, in accordance with the very latest advances of marine engineering. Electricity is used for every possible purpose, including propulsion, the operation of all auxiliary machinery, cooking, heating, and lighting. Movements of the ships are controlled directly from the pilot-house, and not by signals to the engine-room in the usual manner. Because of these features, which have never before been combined on an ocean-going dredge, new standards have been set.

The principal work of these dredges is to keep the outer channels of our harbors clear of the sand that is always tending to fill them up. This service is essential in order to prevent interference with our foreign commerce; and it is believed by the Engineer Corps that this new type of dredge will operate more expeditiously and at less cost than the older steam types.

On completion, the A. MACKENZIE will be assigned to Mobile Bay, the W. L. MARSHALL to the North Atlantic Coast, the DAN C. KINGMAN to the South Atlantic Coast,



The two Diesel-electric dredges *A. Mackenzie* and *W. L. Marshall* immediately after the launch at the Sun Shipyard, Chester

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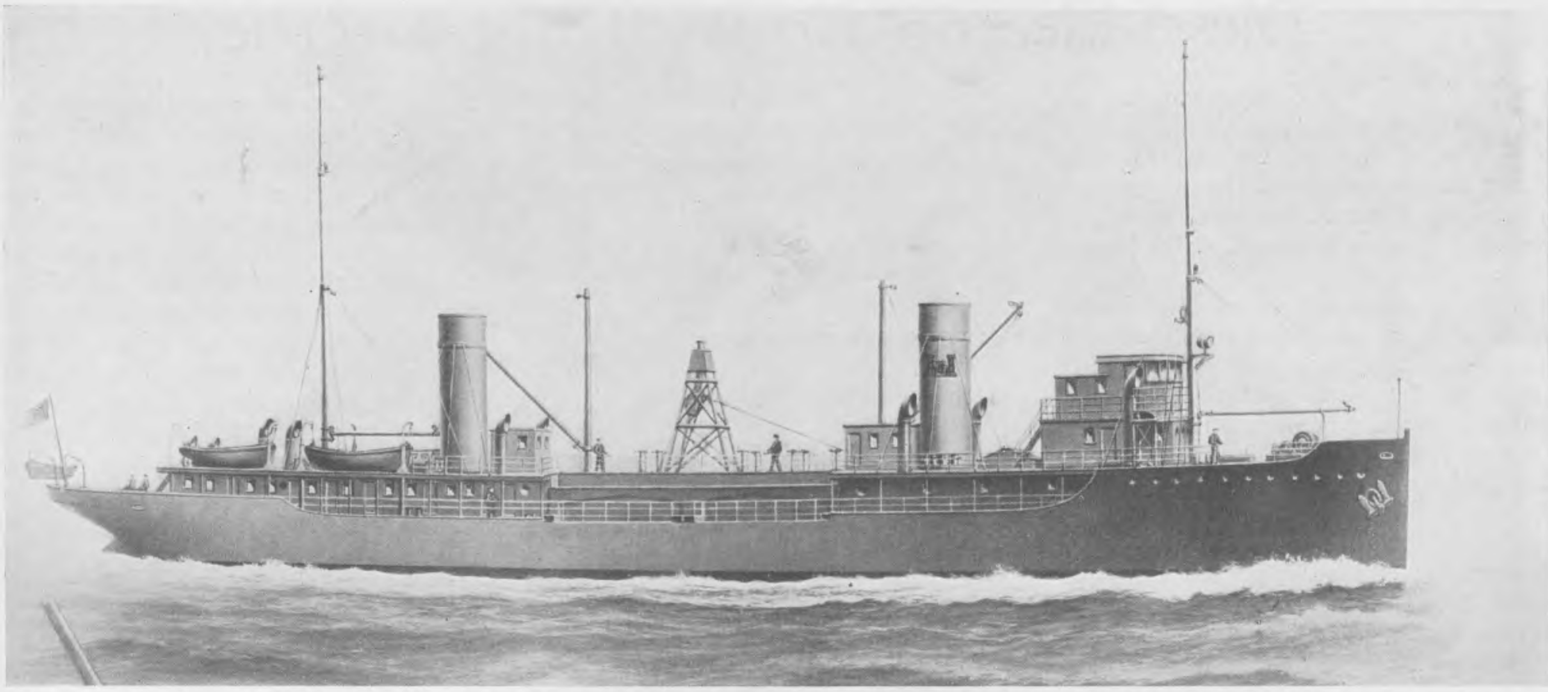


How the U. S. War Department's four new Diesel-electric dredges will look when completed. Electricity is used for every possible purpose

and the WM. T. RUSSELL to Coos Bay.

At the launch and the luncheon which followed, a considerable number of important government, shipping and engineering officials were present, including General Harry Taylor, U. S. War Department; E. M. Herr, and H. T. Herr, President and vice-president, of the Westinghouse Electric & Manufacturing Co., respectively; John G. Pew, President, Sun Shipbuilding Co.; Walter Thaw, Engineer, Westinghouse Elec. & Mfg. Co.; Harte Cooke, McIntosh & Seymour Corp.; Congressman Thomas S. Butler, Chairman Naval Affairs Committee; J. Howard Pew, President, Sun Co.

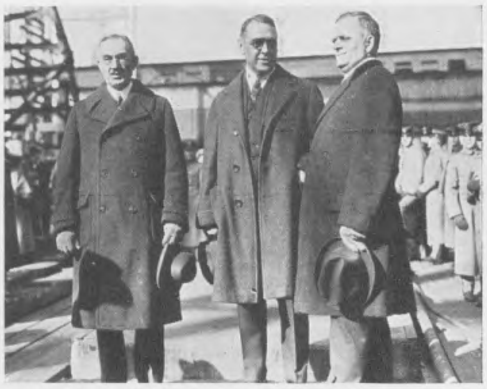
The vessels were designed by and constructed under the supervision of Major R. W. Crawford, U. S. War Department, Washington, D. C., the naval architect being T. R. Voegel.

In a speech, Mr. H. T. Herr said among other things, that "these ships mark another milestone in the development of mechanical and electrical appliances suitable for the operation and progress of our civilization. Their construction distinctly indicates the tendency of the times in engineering to utilize electricity to the fullest extent. These ships are operated entirely by electrical appliances."

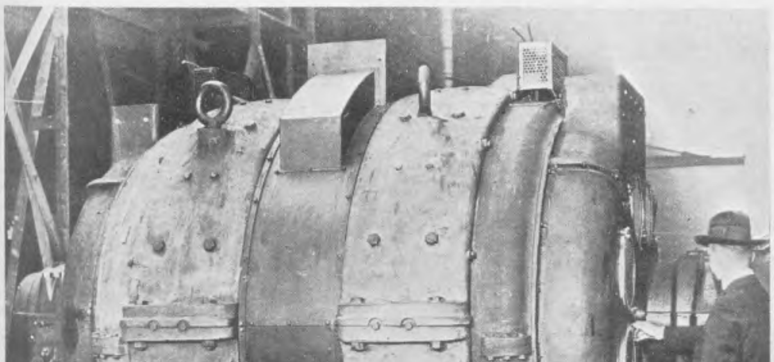
Continuing, Mr. Herr stated that "Light, heat and power are essential in our modern civilization. By the aid of electrical appliances it is possible, by the generation of power alone, to electrically convert this power into either heat, light or power, and to apply it in the most efficient and most convenient manner.

"These ships are epoch-making. They take advantage of complete electrification for the propulsion of the ship itself, for lighting, heating, ventilation, cooking—in fact for every possible purpose. This is accomplished by the installation of Diesel oil-engines operating electric generators and using the current from these generators to operate motors for all power purposes about the ship, with electric current applied for heating and lighting, so that there is in this ship installation the complete idea of a central power-station.

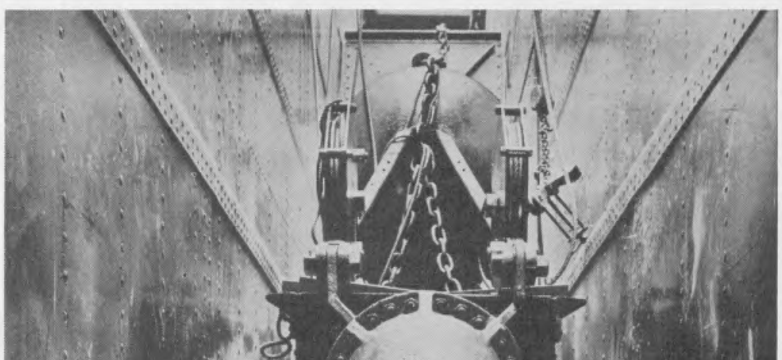
There are on each dredge 56 electric motors, 100 electric heaters, 25 electric fans and 2 electric ranges. These dredges are perhaps the first habitations of civilized man where fire in some form or other is not needed."



At the launch of the dredges *A. Mackenzie* and *W. L. Marshall*. Left to right, Major-General Harry Taylor, U. S. War Dept.; H. D. Herr, vice-president, Westinghouse Elec. & Mfg. Co.; John G. Pew, president, Sun Shipbuilding Co.



One of the twin 800 shaft h.p. Westinghouse electric propelling motors of the dredge *A. Mackenzie*, which motor really consists of two of 400 h.p. built in the same frame. It is totally enclosed and water-proof



The business end of the electric dredge *A. Mackenzie*. The heavy steel casting in the foreground is a drag and is attached to the end of a 40 ft. pipe. The drag ploughs up mud and silt, which is then sucked up through the pipe

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Diesel-Electric *Versus* Turbo-Electric

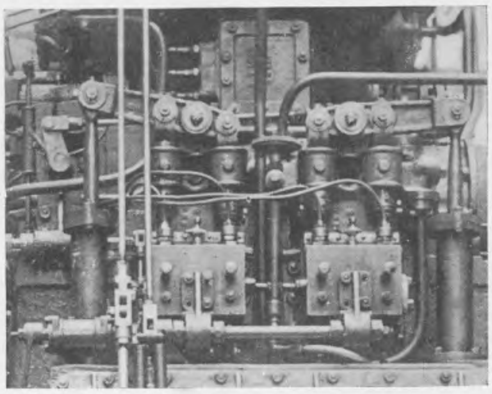
Conclusion of the Interesting Comparison Between the Motorship La Playa and the Steamer San Benito

Part II

(Continued from page 793 November 1923)

REFERRING again to the LA PLAYA's comparison with the turbo-electric ship SAN BENITO, it may be recalled that in our issue of December, 1921, on page 963, Elmer A. Sperry of gyroscope fame said, after an inspection of the engine-room:

"I was glad to avail myself of an invitation to visit the steamer SAN BENITO. I was accompanied by some men who have devoted a lifetime to engine-room equipment and operation of fleets of ships at sea. When we finally descended into the engine-room and commenced to familiarize ourselves with the detail of the equipment crowded into this room, we looked at each other and agreed that here again we failed to find the simplicity that was expected. Every available foot of space seemed to be occupied by machinery. One had to climb over and on top of one after the other to get about. In fact, there were so many auxiliaries that their proper accessibility was difficult. For instance, there seemed to be no way to get at the condenser tubes for replacement or very readily even for inspection. And what was most surprising of all was the relative location of boilers, turbo-generator condensers and the array of auxiliaries on the one hand, and the motor at a point very remote aft, on the other, in a compartment by itself which seemed very difficult of access. I doubt if the motor-room would be visited very often or very willingly, especially in heavy seas.

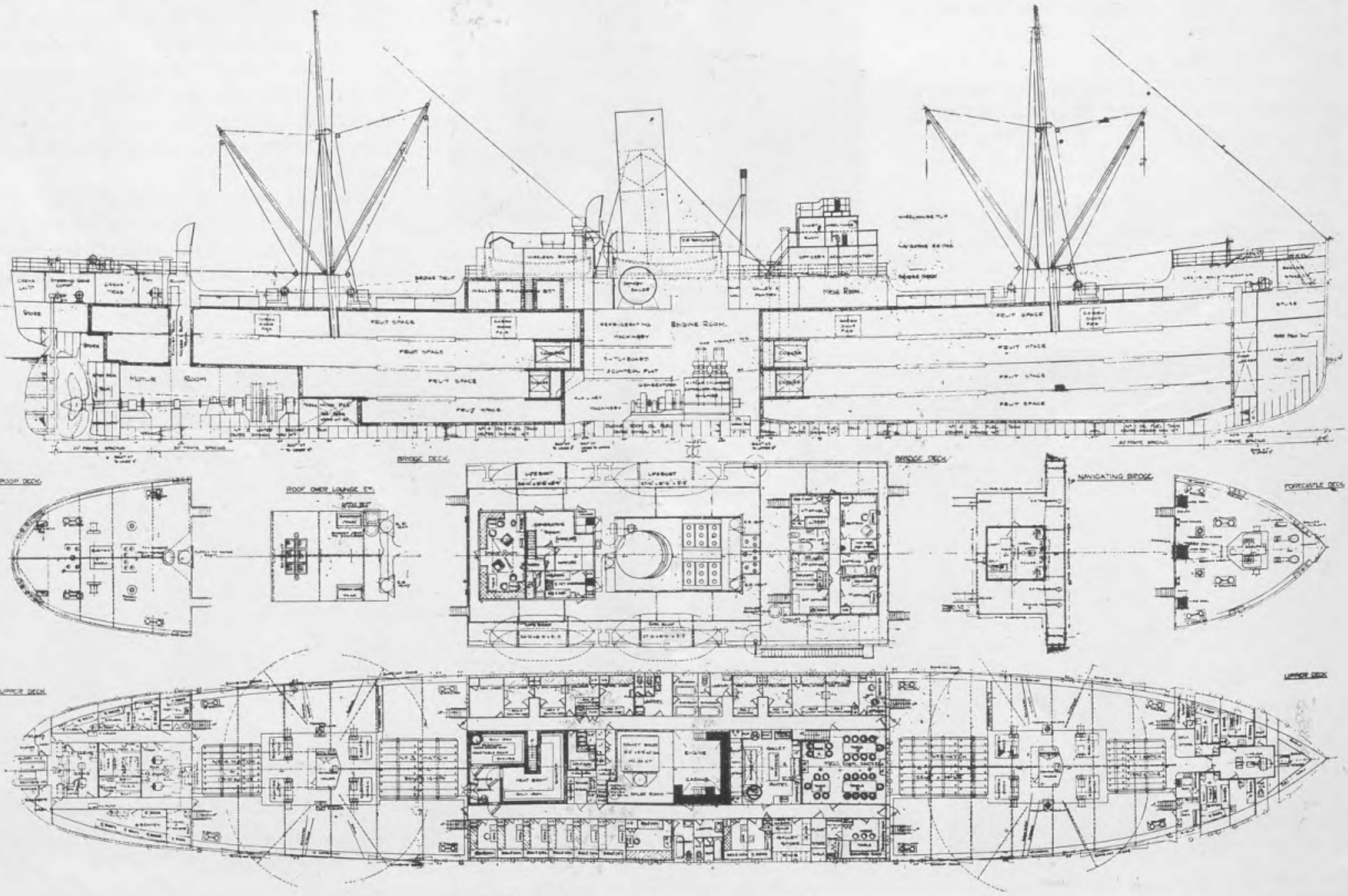


Fuel pump mechanism of a Cammell-Laird Fullagar engine of the *La Playa*

"I am constantly struck with the complexity and maze of machinery, fittings, pipe connections, etc., that go to make the ensemble that one now encounters in the engine-rooms of steamships. As an engineer I cannot but believe that the hour has struck on this ever increasing complexity. A well-known engineer, in speaking on this subject recently, stated that a new steam auxiliary was born every day and that he was literally putting down a separate building to accommodate them. It seems to me that marine engineers should stop long enough to think where this is leading them. Especially is this true in face of what light and low-cost Diesel plants would be able to do, where there are practically no auxiliaries and where the fuel is burned drop by drop, directly driving powerful pistons, instead of the wasteful bulk of firing with all its attendant losses, indulged in wherever steam is employed. The single matter of doing away with the boilers and their troubles and the boiler auxiliaries and their troubles is of paramount importance as an item by itself."

We reprint these remarks in order to emphasize the great difference between the engine-rooms of the SAN BENITO and the LA PLAYA as reference to the drawings on the next page will endorse.

All the propelling generator and motor fields are separately excited from one of the auxiliary generators and starting, stopping, and reversing of the propeller are effected entirely by varying the excitation of the main generators or generator as the case may be. Control arrangements are such that the main propelling circuits are never interrupted and all regulation and reversing is carried out by varying the field circuits only. Provision is, however, made for isolating any of the generating units.



M.S. *La Playa*—General arrangement plans

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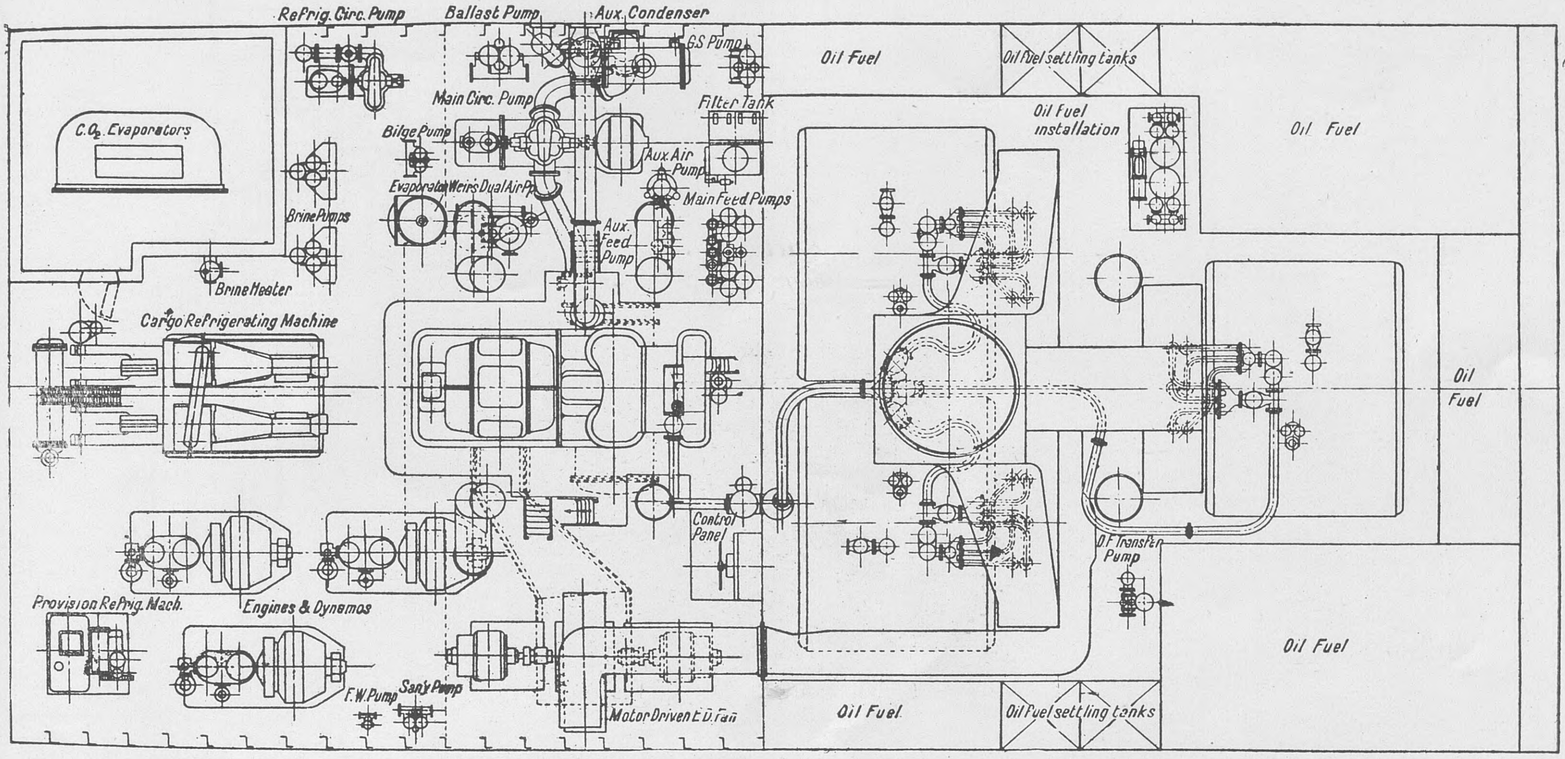


Engine-room plan of the turbo-electric fruit-carrying steamer *San Benito*. This reproduction is to the same scale as the engine-room plan of the sister ship *La Playa* (Diesel-electric drive) shown below which has 1 ft. more beam. There is a difference of nine 2½ ft. frame spaces, or 22′ 6″

Controlling is carried out by means of a lever attached to a small controller fixed to the front of a sheet steel panel carrying the necessary instruments. This lever moves in a fore and aft direction on either side of a central stop point, and all the operator requires to do when maneuvering is to move the lever on to the speed point required either ahead or astern. Actual varying of the propelling generator fields during maneuvering is effected by means of a reversing potentiometer rheostat in each generator field circuit and all the rheostats are simultaneously operated through gearing by a small electric motor. A movement of the control lever merely switches this small motor into circuit and by means of follow-up gear the small motor switches itself out, and stops when it has moved the field rheostats to a position where a field strength is obtained on the generators corresponding to the speed point where the lever is at rest on the controller.

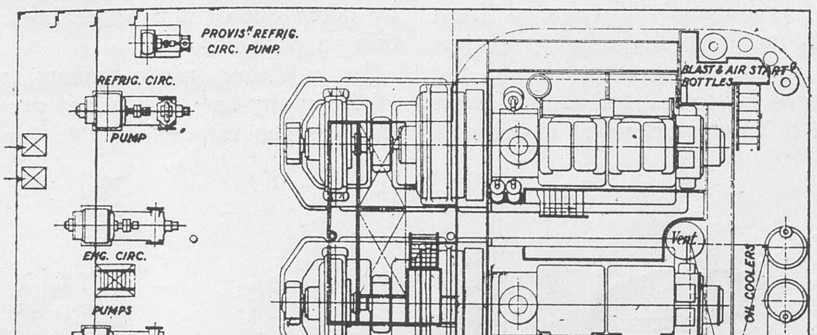
In addition, a special type of overload current relay is placed in the main circuit and this is arranged so that should the operator attempt to accelerate or decelerate too quickly and so cause an excessive power current to flow in the system, the relay interrupts the supply to the small rheostat motor, and although the lever may be operated quickly the varying of the generator field strength is only carried out when the relay again completes the supply circuit to the small motor. This allows the operator to carry-out orders in the quickest possible manner and safeguards the equipment against careless handling.

On the instrument panel there is an electric propeller speed indicator giving R.P.M. ahead and astern. One indicating wattmeter for each engine set gives the sum of the auxiliary and propelling loads in kilowatts, and enables the operator to see at a glance the load conditions on each engine without having to calculate them from the volts and ampere readings of the two generators.

Adjacent to each of these wattmeters is a handwheel by means of which the fields on each of the propelling generators can be adjusted and that particular propelling generator's contribution to the propelling-power circuit varied so as to maintain full kilowatt load on the engine. It also enables any particular engine load to be conveniently reduced should there be a minor defect in the engine important enough to warrant a complete stoppage.

A voltmeter with a six-point switch is provided to enable the operator to read the voltage of any of the four main generators, the motor volts, and the exciter volts. There is an ammeter which reads the propelling power current, this being the same current as is supplied by the generators in series, and a wattmeter also calibrated in electrical horsepower provides a convenient form of measuring the power developed by the motor without the operator requiring to make a mental calculation from the varying volts and amperes.

The two last mentioned instruments are placed near the speed indicator, and a hand wheel is conveniently placed alongside which operates a rheostat in the propelling motor field circuit and enables the motor



La Playa*—Plan of the engine-room—Comparison should be made with the engine-room plan to the same scale of the turbo-electric ship *San Benito

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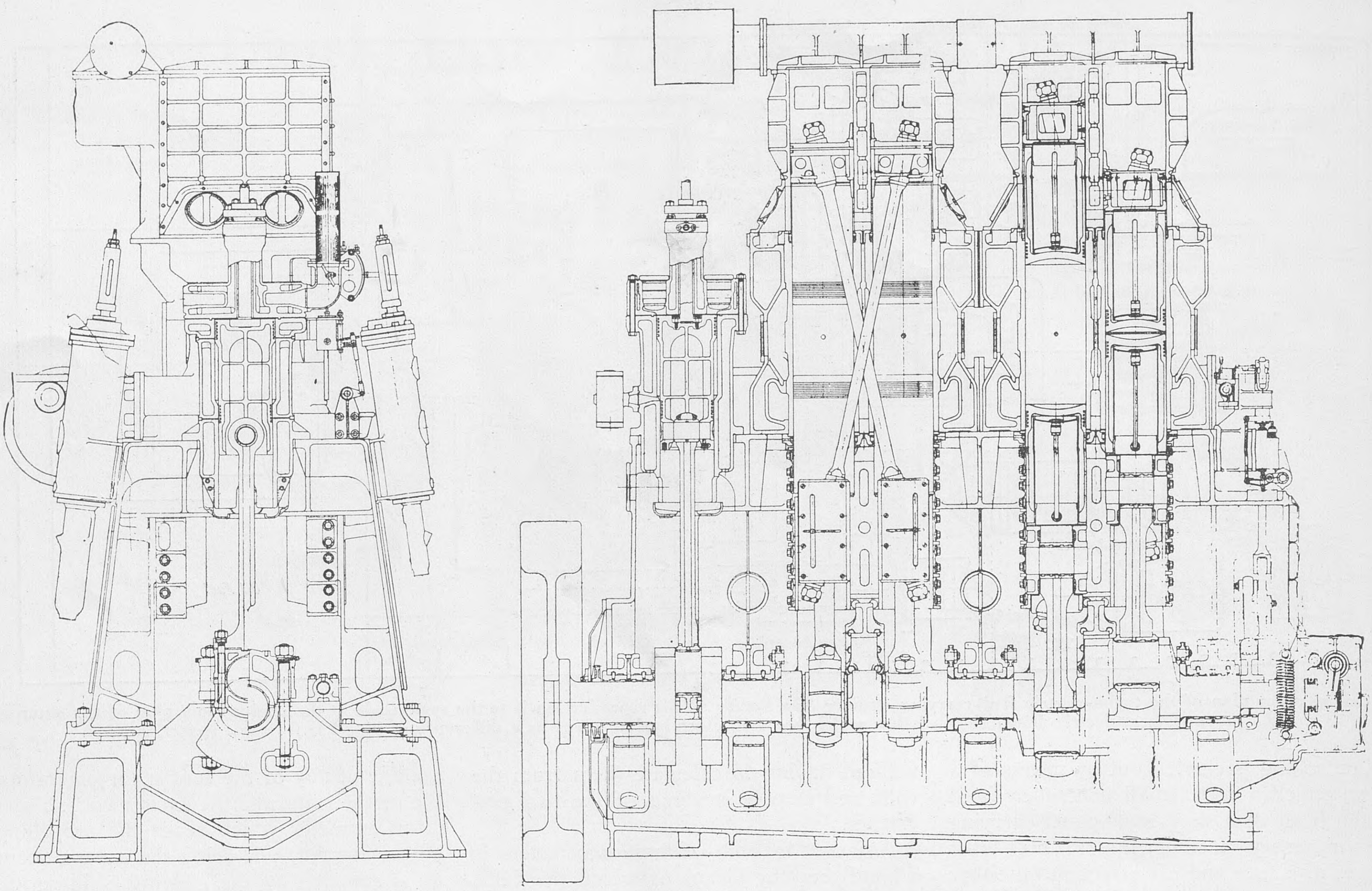


La Playa—Sectional drawings of one of the four 825 b.h.p. Cammellaird-Fullagar Diesel engines

field to be varied and the speed consequently adjusted to compensate for temperature variation, or light draught conditions.

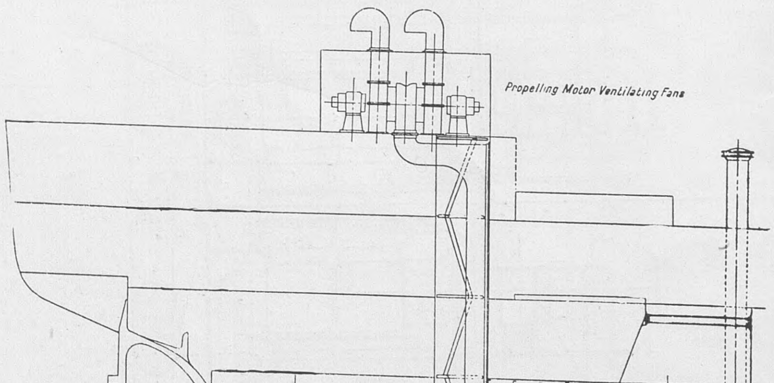
As a precaution against failure of the small rheostat operating motor, which might conceivably fail when maneuvering the vessel in narrow waters, a hand wheel is placed close to the control lever by means of which the propelling generator field rheostats can be manually operated. This hand wheel is normally disengaged from the rheostat operating shaft, but is always ready for instant engagement should the propeller speed fail to respond to movement of the control lever, and when engaged it automatically cuts the small rheostat motor out of circuit. The hand wheel is geared so that it can conveniently be operated through a full-power reversal in about 30 seconds.

The auxiliary load is controlled through 5 point selector switches, this arrangement enabling the auxiliary load to be distributed over four auxiliary generators and any one of the four propelling generators which can be taken out of the propelling circuit for this purpose.

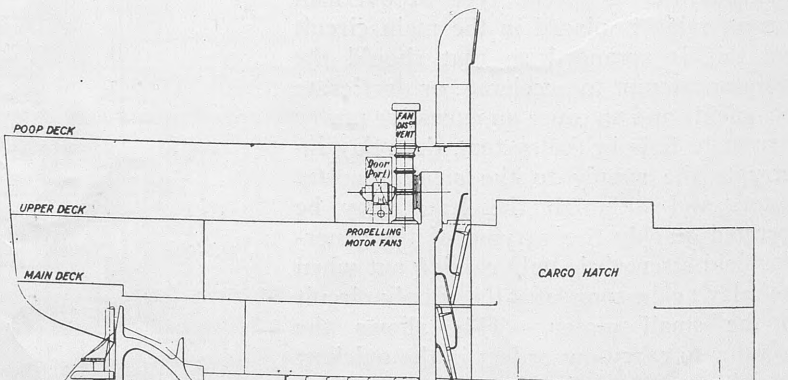
In addition arrangements are made whereby any one (for two if necessary) of the five generators available for auxiliary power can be run at a reduced voltage, this arrangement being principally devised in order to give a convenient speed control to the large refrigerating motors.

One of the features of the electrical installation is the main switchboard, fitted thwartship at the after end of the engine-room. It consists of 15 panels and has an overall length of 32 feet. Five generator panels are included, one for each of the four auxiliary generators and the fifth for any of the main generators when used to supply auxiliary load.

For lighting purposes at sea a motor generator 220/110 volts is provided, whilst for



Propelling motor installation of the turbo-electric steamer *San Benito*



Showing space occupied by the propelling motor of the *La Playa*

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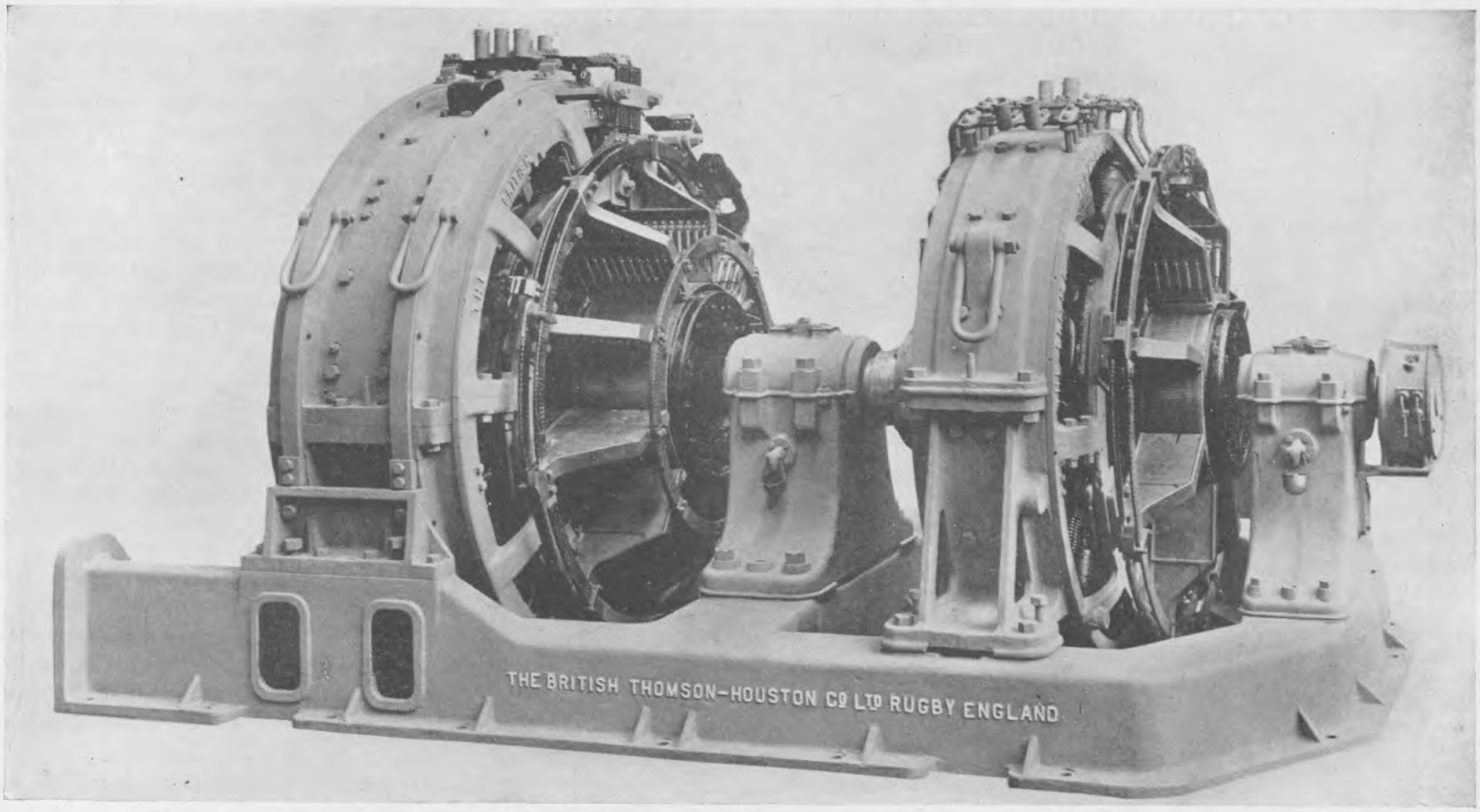


M.S. *La Playa*—One of the four British Thomson-Houston (General Electric Co.) tandem generating-sets, consisting of one 200 k.w. auxiliary generator and one 500 k.w. main generator

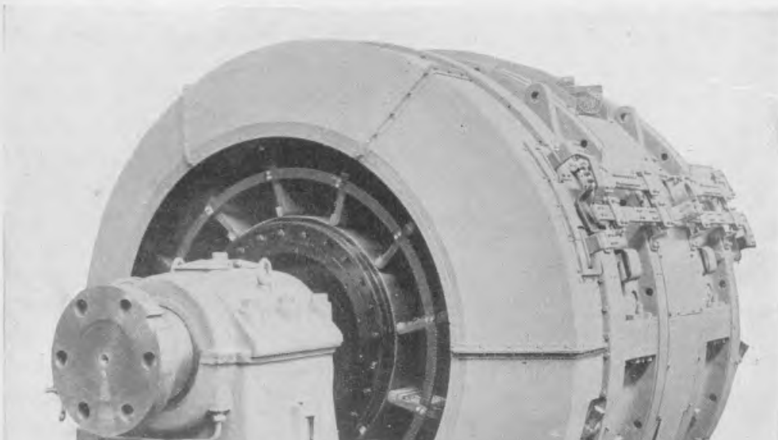
harbour use and starting up purposes a paraffin-driven 110 volt 25 k.w. generating set is installed. Provision is made on the switchboard for running the above mentioned motor generating set to supply 220 volts for running the provision room refrigerating plant when in port.

The deck machinery is also electrically driven and consists of nine Sunderland Forge-type worm-geared winches, each capable of lifting a load of 10,000 lbs. at 85 feet per minute, and fitted with a 32 h.p. motor, complete with watertight control gear. One of these winches is arranged with extended ends for warping purposes. The windlass is driven by a 52 h.p. motor.

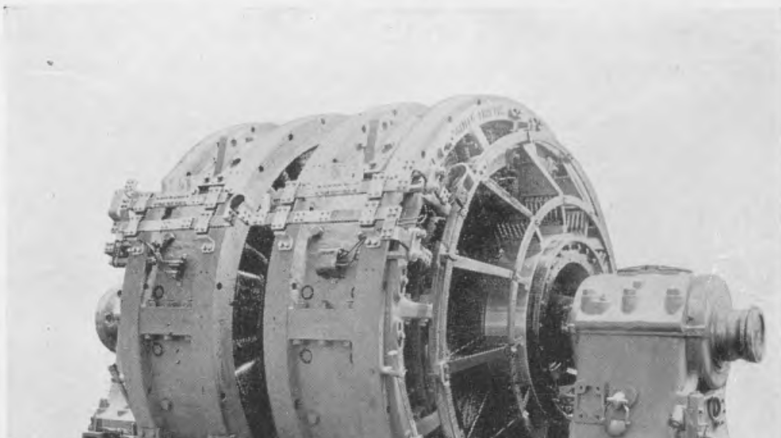
A small electrically driven Weir air-compressor is supplied for initially charging the air bottles, and arranged to take current from the 25 k.w. auxiliary paraffin-driven generating set. In addition, an electrically driven "Albany" pump is provided for standby forced lubrication duties, while a De Laval oil purifier is also fitted for cleaning the lubricants. This device effects a considerable saving in lubricating oil, and retards wear of the bearings.

In order to deal with the oil fuel stored in the double-bottom under the very severe winter conditions frequently experienced in North American ports the "R and D" system for reliquefying the oil fuel is installed. In this system oil fuel, after having been raised in temperature by special heaters, is discharged through revolving nozzles fitted in the double bottom tanks, adjacent to the oil-fuel suction pipe, by this means raising the temperature of the oil until it can be dealt with by the service suctions.

Progressive trials were carried out on the measured mile at Skelmorlie. The vessel afterwards proceeded for a five days cruise round the coast of Ireland in order to familiarise the ship's engineers with the operation of the machinery. This cruise was carried out at about the full service power of the vessel and was entirely satisfactory. Adverse weather was encountered.



M.S. *La Playa*—The British Thomson-Houston 2,500 shaft h.p. double-unit propelling motor



M.S. *La Playa*—The double-unit propelling motor showing casing partly removed

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NEW MOTOR WORKBOAT AND MOTORSHIP CONSTRUCTION AND GENERAL NEWS NOTES

A SMALL oil-engined vessel is to be laid down at the Sun Shipyard for their own use.

The Puget Sound halibut schooner EAGLE has been equipped with a 135 b.h.p. Enterprise oil-engine.

Two 14,000 tons d.w. motorships will be acquired by, or built for, F. Bosel Seeschiffahrtsges. of Vienna and Trieste.

LA MAREA, the second of the three sister Diesel-electric motorships for the United Fruit Line, was launched on October 25.

Nearing the launching stage at Harland & Wolff's Belfast yard is a 9,000 tons gross motorship of the LOCHGOIL class.

Capt. J. A. Cates, a Pacific Coast towboat man, has installed a 125 b.h.p. Atlas-Imperial oil-engine in his 60 ft. tug RADIUS. His tug PROVINCE is also Diesel powered.

Plans for New York City's fleet of Diesel electric ferry-vessels are being pushed forward, but will not have reached the stage of calling for bids until early in 1924.

In the schooner PRISCILLA ALDEN a Standard oil-engine has been installed at the Tebo Plant of the Todd Shipyards Corp., N. Y.

A shallow draft motor-tug for South America is now under construction at Jacobs Yard, City Island, N. Y. A 80 b.h.p. Mianus oil-engine has been installed.

A 65 h.p. Enterprise oil-engine has been installed in the Puget Sound halibut-schooner RANIER, to the order of Bernhard Ransen & Oly Knutsen.

Capt. Andrew Olson is substituting the 100 h.p. gasoline engine of his halibut-schooner VANSEE with a 165 b.h.p. Enterprise oil-engine.

Two 56 ft. motor-tugs have been ordered in England for the British Colonial Government. In each boat a 450 shaft h.p. Diesel engine will be installed.

For the sale of British Admiralty Charts in the State of California, George E. Butler, 356 California St., San Francisco, Calif., has been appointed agent.

Ten manufacturing licenses for the Still combination oil-and-steam engine have been disposed of covering marine, stationary, locomotive and road traction.

The Panama Canal authorities have reduced the price of Diesel oil to $2 per bbl. at Balboa, and $2.35 per bbl. of 42 gallons, at Cristobal.

A 135 b. h. p. Bolinder oil-engine will be installed in a coastwise tanker for the Anglo-American Oil Co. by James Pollock Sons & Co., Faversham, England.

WANG will be the name of the new Sulzer Diesel-engined motorship now building for the Rotterdam Lloyd at the De Schelde Shipyard, Holland.

The first of two 8,000 tons Diesel-engined ships for the Norden Line (P. Braun, Jr., & Co.) should be delivered by Burmeister & Wain by the time this appears in print.

An oil-engined fishing-boat towed ashore the crew-laden boat of the steam-trawler ALEXANDERITE when she was wrecked on the rocks at Speeton Cliffs on the East Coast of England.

Two 50 ft. deep sea fishing boats are building for Smith Bros., Santa Rosa, at J. H. Madden & Co's. plant, Los Angeles. Both will have a 45 b.h.p. Fairbanks-Morse oil-engine.

Exhaustive tests on the Pacific-Werkspoor Diesel engine of the new Port of Portland dredge have just been carried-out under the supervision of D. W. Dickie of San Francisco.

Vaccaro Brothers, New Orleans, La., have ordered a 350 ft. passenger and banana carrier from Workman, Clark, of Belfast, as well as a ship from Swan Hunter & Wigham Richardson, Wallsend-on-Tyne.

Recently a 1,300 mile trip from Seattle to San Pedro was made by Mr. Hold's motor-yacht SAMONA. This vessel is powered with three 100 b.h.p. Atlas-Imperial Diesel engines.

ASTURIAS and AMAZON will be the names of the two 22,000 tons gross double-acting Diesel-driven passenger-liners now building for the Royal Mail Line at Harland & Wolff's East yard at Belfast.

The Ford motorship building at the Great Lakes Shipyard is being classed to the American Bureau of Shipping. The sister motorship building by the American Shipbuilding Plant is being constructed to Lloyds classifications.

The gas engine of the harbor tug PROSPECT POINT, owned by H. Bruner, of Vancouver, has been replaced by a 70 b.h.p. Wolverine oil-engine, turning at 350 r.p.m. Trials and towing tests were recently run with success.

Six motor-tugs are being constructed by the Wilmington Tug & Barge Co., of Los Angeles. Three Winton Diesels and three Fairbanks-Morse oil-engines are being installed. The first of the fleet has been launched.

Young Bros., Honolulu, H. I., have had a 300 b.h.p. Fairbanks-Morse oil-engine installed in their tug MIKIOI, built in 1920 and originally fitted with a gasoline motor. Her fuel bill has dropped from $8 down to $0.85 per hour. Some drop!

Two 600 shaft h.p. Worthington four-cycle oil-engines have been ordered by the Construction Materials Corp., of Chicago and New York, for installation in the steamer LAKE WEIR just purchased from the Shipping Board.

TORTUGAS, one of the numerous new motorships built at the Deutsche Werft, Hamburg, recently ran trials. She is of 6,200 tons d.w.c. and of 2,800 i.h.p. in twin A.E.G.-B.&W. Diesel engines. She was launched on August 30 last.

SATURNE, a 124 ft. by 21 ft. by 12 ft. 3 in. Boulogne trawler, has been equipped with a 500 b.h.p. at 190 r.p.m. Chaleassiere (Sabathé) Diesel engine. The cylinder bore is 370 mm. (14.56") by 650 mm. (25.59") stroke.

A license to construct the Augsburg marine Diesel-engine in France has been secured from the M. A. N. by the Société Generale de Constructions Mecaniques, formerly E. Garnier et Faure Beaulieu, of La Courneuve.

Under the Doheny contract made in 1922, the U. S. Navy has planned 48 tanks for storage of Californian oil-fuel at Pearl Harbor, Honolulu, forming the world's largest storage of Diesel-oil, gasoline and lubricants. The total capacity is 1,835,000 barrels and the cost about $7,900,000.

As a protest against the 5% wage reduction on Oct. 6th and a further wage reduction of 5% on Jan. 4th next, nearly 100 riveters' assistants have gone on strike at the Netherlands Shipbuilding Co., Amsterdam, where two 12,300 tons motor tankers are under construction.

Beardmore 60 b.h.p. oil-engines are being installed in the two 60-ft. wooden cruisers building at Prince Rupert, B. C., for the Dominion Government Fisheries Service. A Gardner gasoline-driven electric-generating and air-compressing set form the auxiliary machinery power.

According to the *Panama Canal Record*, the motorship CALIFORNIAN of the American-Hawaiian Line, which passed through the Canal northbound on October 10, had on board a case of paintings valued at $1,400,000 loaded at San Francisco for a museum in New York City.

The Shipping Board's motorship WILLIAM PENN is expected to reach New York during December. She has been making a considerable number of ports with only short runs in between, but her operation has been up to the usual high standard for this vessel—everything going well and no trouble.

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Every American shipowner that orders a motorship should class his vessel with the American Bureau of Shipping. We can recommend the Bureau's Rules for Construction of Oil Engines, which were published in detail on page 27 of the 1922 MOTORSHIP YEARBOOK.

The unemployment relief-work plans of the British Government include the setting aside of £2,600,000 for subsidizing construction of new ships for the big British shipowning companies. It is possible that this sum includes a guarantee on the Royal Mail S. S. Co's. two new 22,000 ton Diesel-driven liners.

Two 100 b.h.p. Winton-Westinghouse Diesel-electric sets are being installed as propelling power in the steam yacht CUTTYSARK, owned by Alexander Smith of Peabody, Houghteling & Co., New York. The conversion work is being done by the Morse Dry Dock Co. at a cost of $45,990, exclusive of the price of the machinery.

The motor-tanker ALASKA STANDARD, now building at San Francisco for the Standard Oil Co., of California, will be equipped with steering gear, anchor windlass and capstan, built by Allan Cunningham, of Seattle, as will the motor-tanker now building at Newport News for the Standard Oil Co.

Lloyds on June 30 last were supervising the construction of 175 Diesel marine oil-engines aggregating 246,000 brake horsepower. It may be a surprise to learn that 92 are two-cycle and 83 four-cycle. Their value exceeds $12,500,000. The number is now greater owing to recent orders exceeding deliveries.

Owen & Watkin Williams Co., of Cardiff, Wales, the big coal concern, has accepted delivery of the new motorship MARGRETIAN, built at C. Hill's shipyard, Bristol, Eng., and recently loaded 4,500 tons of coal for West Italy. She is powered with twin six-cylinder Charlton-Beardmore two-cycle oil-engine sof 750 h.p. each.

VANADIS, the new motor yacht for C. K. G. Billings was launched on Nov. 15th. She is being equipped with two 900 shaft h.p. Krupp Diesel engines which will give her a speed of 14 knots. Her length is 240 ft., breadth 35 ft. and draft 14 ft. She was designed by Cox & Stevens, of New York, and will be delivered early in 1924.

It has been reported that P. Deren, of Valparaiso, is interested in purchasing two motorships of 7,000 tons d.w. from Belgian owners. We know of no such vessels. Our records only show two Diesel-driven tankers of this size under the Belgian flag, one of which was sunk during the war and the other converted to steam by a company who has since actively taken up the construction of Diesel engines.

Recently the new Great Lakes motor cargo-carrier TWIN PORTS arrived in New York from Duluth, via New York State Canal, carrying a cargo of butter and flour, including a gift to the Mayor of New York from the Mayor of Duluth of a barrel of flour and a tub of butter. This was turned over to the Department of Public Welfare to make into cakes for the crippled children on Vanderbilt Island.

In the new passenger river motorship THOR II, which ran trials on October 25, a 260 shaft h.p. Bolnes oil-engine has been installed. This craft is owned by the Stoomboot Rederij Arie Smit of Slikkerveer, Holland, and was built by Van der Giessen & Zonen, of Krimpen, A/D Yssl. Length 146 ft., breadth 23 ft., depth 8 ft. 6 in., speed 10 knots and carries 700 passengers and 40 tons cargo.

Recently the motor-tanker BRAMMEL POINT was sold to the General Petroleum Corp. and renamed LOS ALAMOS. In the last three months this McIntosh & Seymour Diesel-engined vessel has covered over 15,000 miles without any trouble to speak of. In fact, she has not had a stop at sea once. The auxiliary steam machinery is the only thing that has given trouble, and this is being improved.

The Allan Cunningham Co., of Seattle, have produced a new electric towing-engine which is being installed in the Vancouver tug LUCIENNE, powered with a Sulzer Diesel engine and which recently crossed from Europe under her own power. The Allan Cunningham Co. is now prepared to offer these towing-engines either as plain electric non-automatic towing machines, or as full automatic towing machines with an automatic relieving gear.

The Augsburg plant of the M. A. N. has been recently experimenting with a two-cylinder, double-acting Diesel engine, 620 mm. (24.40 in.) bore by 1,050 mm. (41.33 in.) stroke. About 1,600 shaft h.p. is developed. The engine is of the port scavenging system and the mean effective pressure is 75 lbs. per square inch. This engine has but little resemblance to the big two-cycle, double-acting engine built at Nurnberg, and described elsewhere in this issue.

An interesting bulletin entitled "Achievement of Motorships" has just been issued by the McIntosh & Seymour Corp., of Auburn, N. Y. This bulletin describes and illustrates a number of motorships recently equipped with McIntosh & Seymour Diesel power, including the motorships MOTOR PRINCESS, STEELMOTOR, STEEL VENDOR, TROY SOCONY, War Department's sea-going hopper-dredges and 24-inch pipeline-dredge, and the motorships MUNMOTOR, MUNCOVE and KENNECOTT.

Trials were run on November 21st of the new cargo-vessel which the Scott Shipbldg. & Engr. Co., of Greenock, have built and engined for Alfred Holt & Co., of Liverpool. This vessel is the first "motor-steamer" to be placed in service, being propelled by twin Scott-Still combination steam-and-oil engines developing together 2,500 shaft h.p. at 120 r.p.m. The Diesel half of these engines is of the two-cycle type, each engine having four cylinders 22 in. bore by 36 in. stroke.

The Lombard Governor Co., of Ashland, Mass., have opened an office at 30 Church Street, New York, for the sale of Lombard Diesel marine and stationary type engines. This office is in charge of W. Merton Rice, who recently was associated with Cox & Stevens and with Henry J. Gielow, Inc., New York naval architects. Mr. Rice will be glad to give the benefit of his experience to anyone who desires an analysis of power costs.

From Russia has come a copy of an interesting new magazine known as *Torgovy Flot*, meaning The Mercantile Marine. It is the second number and was issued in September. In addition to a considerable amount of general shipping and shipbuilding news, there are a number of articles on motorships and Diesel engines. The magazine is well printed, but entirely in the Russian language, so, unfortunately, we are unable to give it a proper review. The office of publication is 14 Panteleimonskaja, Petrograd, and its editor is Mr. Velter.

We have received a booklet from Wm. Beardmore & Co., Ltd., of London, Coatbridge and Glasgow, giving details of the new intermediate type oil-engine which has been developed in sizes up to 750 shaft h.p. in six cylinders, for coastwise ships and fishing boats. It is of the two-cycle type, designed by Mr. Chorlton, and a pair of 750 h.p. engines have been installed in the freighter MARGRETIAN, vessel 310 ft. length overall, 297 ft. length b.p., 43 ft. breadth and 32 ft. depth.

Alfred Holt & Co., of Liverpool, have placed an order for Diesel engines for another motorship to be built by Workman-Clark.

Four cargo ships for American owners are now building at the yards of Swan Hunter & Wigham Richardson, Wallsend-on-Tyne, England. Two are Diesel-driven and two are steam-propelled.

Another 12,800 tons motor-tanker has been ordered by a Norwegian shipping concern, presumably for American interests, to carry our oil under the more favorable conditions of the Norwegian flag. This order has been placed by Knut Knutsen, of Haugesund, with the Nakskov Shipyard, Nakskov, Denmark, and twin 1,800 i.h.p. Burmeister & Wain Diesel engines will be installed. The hull will be constructed to the Isherwood system. Length 465 ft., breadth 61 ft. 10 in., depth 37 ft. 3 in. Speed 11 knots.

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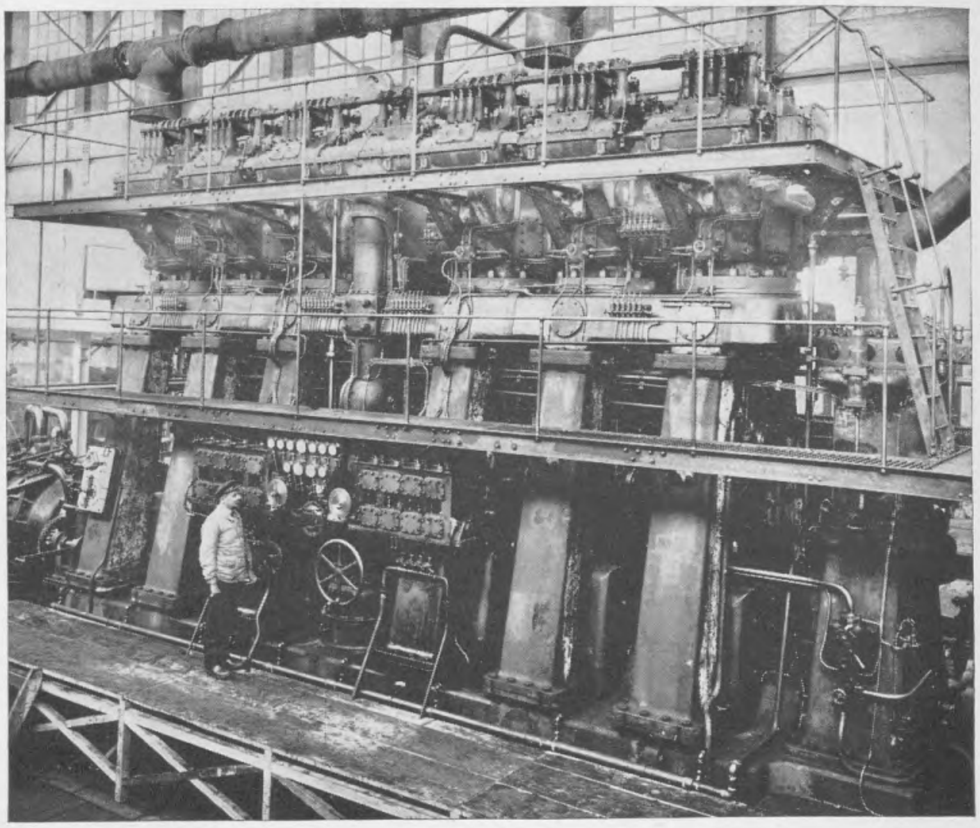
AN ELECTRO-VAPOR RADIATOR

Due to the entire elimination of piping with its inevitable leaks, the electro-vapor type of radiator is being very rapidly adopted for use aboard ships. Several of the latest Transatlantic liners are fitted with it, and the specifications recently put out by the Southern-Pacific for a new vessel included it for the heating of staterooms. It is a British invention and thus not so well known on this side as it is in Great Britain. Harland & Wolff use it on all their motor-vessels, and they have equipped many steamers with it.

Compared with steam it has the advantage of being a self-contained unit that does not leak and does not suffer from water hammer. Compared with an ordinary electric radiator it has the advantage of distributing heat evenly and agreeably instead of concentrating a toasting heat on one small area.

The electro-vapor radiator is virtually a separate steam heating plant consisting of a cast-iron radiator of the ordinary pattern with a chamber permanently attached containing a small quantity of liquid which can be vaporized by an electric heating element contained inside it. The liquid will last indefinitely, but should be checked up about once a year.

The device is listed in a range of sizes having from 8 sq. ft. to 70 sq. ft. of heating surface, the smallest size being suitable for attachment to any lamp socket. The radiators are now made in this country and are handled by Walter Kidde & Co., of New York, who acquired the U. S. rights from Benham & Co., of London.



New Diesel engine of 1,500 s.h.p. built by Schneider & Cie. of France, at the company's branch works at Le Havre. It is of the two-cycle type, based on Carels design, and has six cylinders 21¼ in. by 31½ in. Operating speed 140 r.p.m. Weight with flywheel about 175 tons

Electro-vapor type of unit radiator which is coming into vogue

The Motor Tanker "Bidwell"

Great interest was manifested in San Pedro, Cal., on the arrival of the motor tanker BIDWELL. This is one of the vessels which the Sun Shipbuilding Co., of Chester, Pa., has converted from steam. The vessel is owned by the Sun Oil Co., and J. N. Pew, Jr., Operating-Manager for that firm, met the vessel at San Pedro and arranged for a trial run and inspection to be given to a number of Californian people. Robert Haig, Vice-President of the Sun Shipbuilding Co., who was in California at the time, was on hand to explain the special features of the machinery. His firm, it will be remembered, built the 3,000 i.h.p. Doxford-type oil-engine installed in place of the original steam machinery. The BIDWELL loaded a cargo of fuel-oil for the Bayonne Refinery of the Standard Oil Co., of N. J.

Dutch Shipping Year Book

A yearbook dealing with shipping and shipbuilding in Holland has been produced by Moorman's Periodieke Pers, of The Hague. It has just made its first appearance and covers the year 1923. It is a large volume with 154 pages measuring about 10 in. by 12 in. and includes complete financial and commercial data on all Dutch shipping companies, a detailed list of all Dutch steamers, motorships and sailing vessels, besides a list of all boats built in that country during 1922. An interesting section is devoted to lists of associations and officials connected with marine matters.

MILLION TONS OF LARGE MOTORSHIPS

(Issued by Dept. of Commerce, Washington, D. C.)

The world tonnage of full-powered ocean-goging *motorships of 2,000 gross tons and over, aggregated* nearly 1,000,000 tons on June 30, 1923—an increase of about four per cent over the total on June 30,1922, according to a study by B. V. York of the Transportation Division of the Department of Commerce. Vessels of British, Danish and American nationality show a slight decrease, compared with the 1922 figure. Germany has shown the most rapid increase in tonnage. The three Scandinavian countries, however, have almost equal amounts. America is second in numbers to Great Britain, but fth in tonnage.

These figures do not tally with those issued by Lloyds, because the latter include all motor vessels of 100 gross tons and over, whereas the Department of Commerce's figures only cover ships of 2,000 gross tons (about 3,000 tons d.w.) and up.

Tonnage of motorships over 2,000 gross tons each, on June 30:

Countries	No.	1921 Gross tons	No.	1922 Gross tons	No.	1923 Gross tons
United Kingdom	34	217,104	52	335,766	48	311,364
Sweden	20	91,681	27	123,753	28	136,204
Norway	21	85,032	27	120,442	27	129,892
Denmark	21	121,580	22	129,507	25	128,499
United States	28	86,457	30	101,672	29	99,151
Germany	..	......	7	32,083	13	59,931
Italy	6	26,349	7	36,476	9	43,433
Other*	15	63,467	14	66,242	14	75,797
Total	145	691,770	186	945,941	193	984,271

*Includes a few vessels not completed or registered.

Motorships of 5,000 gross tons and over increased 10 per cent, amounting to 664,735 gross tons—two-thirds of the total. Countries owning vessels of this class maintain almost the same relative position as under the 2,000 ton classification.

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Parsons Turbine Company Proposes Geared Oil Engine Drive

The reduction-geared oil-engine system as developed in America evidently has impressed British engineers, as the Parsons Marine Steam Turbine Co., Ltd., Newcastle, has proposed to use a number of high-speed, enclosed four-cycle oil-engines with geared reduction to the propeller shaft. In the case of one pair of engines, they are arranged alongside each other; in the case of two pairs, one is situated above the other, the two upper units being pitched somewhat farther apart than the lower two units. The drive from each engine is taken to the propeller through the medium of an elastic frictional coupling, built into the fly-wheel friction clutch and single reduction gearing. This makes it, of course, possible for both propeller and oil engines to be run at widely different speeds. An inspection of the "4-unit" model makes it apparent that the accessibility of the two lower units is inferior to the arrangement indicated by the "2-unit" model. In both cases, of course, any of the units can be cut-out, any possible defect remedied, and the unit connected up again without stopping the vessel.

A novel departure is the proposed utilization of the exhaust gases. The cylinder jackets and an oil-fired boiler form a closed circuit, the water from boiler to jackets passing through a regenerator (vertical type), heated by the exhaust gases. The system is designed to handle steam pressures up to 250 lb. per sq. in., the steam being used for auxiliary purposes in the engine-room. It is claimed that sufficient steam is generated to drive the whole of the engine-room auxiliaries; hence the saving in fuel is considerable, despite the fact of using a less efficient system as compared with oil-engine generators and electric-driven auxiliaries.

Steam is generated in the oil-fired boiler, circulating commences and warms up the cylinder jackets ready for starting. In this respect the method is analogous to that employed in the Doxford engine. It is also possible to use a lower compression, because the higher cylinder temperature ensures a positive start and also makes up for any loss of thermal efficiency due to lower compression and higher speed of revolutions.

For starting the engine, air is used in the conventional way or steam. In the latter case the starting and maneuvering gear is identical to that employed with air, and steam is admitted to the top of the cylinder by some ordinary type of starting valve. Owing to the pre-heating of the cylinders the engine is always certain to get away very quickly and hence the steam consumption is very low.

One proposal includes four trunk type, six-cylinder engines, aggregating 1,200 b.h.p., geared down from 450 r.p.m. to 75 r.p.m., at the propeller. The total weight of machinery, including gearing and propeller gear is 225 tons, and the length of machinery space 26 ft 9 in., plus 5 ft. 6 in. recess. The other, and probably more attractive, system includes two six-cylinder crosshead type engines, also of 1,200 b.h.p. total, with engines at 300 r.p.m. and propeller at 75 r.p.m. Complete weight of machinery in this case is 266 tons, to be accommodated in 32 ft. length of engine room, plus 5 ft. 6 in. recess. Whilst the extensive use of steam may in certain quarters be taken as a retrograde step, the Parsons system embodies a number of points that are attractive from the commercial and practical point. This development in England and its application to marine practice will be watched with considerable interest.

A 3,000 b.h.p. Cammellaird-Fullagar engine is under construction at the Jarrow Works of Palmers Shipbuilding & Iron Co.. England, and will be installed in an oil tanker of 10,000 tons d.w., which is to be built at the Jarrow yard. The engine will have six cylinders of 23 in. bore, in each of which there will be two opposed-pistons with a combined stroke of 72 in. The rated power will be developed at 90 r.p.m.

R. I. N. Tanker Urano

URANO, recently completed in Kiel at the Deutsche Werke for the German Government, which had ordered the vessel on reparations account for Italy, has now been accepted by the Italian Navy. This ship, which is a tanker of 7,935 tons d.w.c., was previously referred to in MOTORSHIP.

From the official information kindly furnished to us by the Naval Attaché of the Italian Embassy, at Washington, we are now able to give the exact measurements of the vessel. She is 414 ft. 9 in. long overall, and 398 ft. 3 in. between perpendiculars. Her moulded breadth is 54 ft. and the moulded depth 30 ft. 5 in. On a loaded draft of 23 ft. 4⅜ in., with winter freeboard, her displacement is 11,220 tons, which is increased by 215 tons with summer freeboard. With fuel, water and stores for a voyage of 10,000 miles, her maximum cargo capacity is 7,350 tons with summer freeboard, but the normal cargo capacity is about 250 tons less. The capacity of her fuel bunkers is 717 tons, which suffices for a cruising radius of approximately 15,000 miles.

The engine details given in the September issue of MOTORSHIP were entirely correct. It may be added that on her trials she made a speed of 10½ knots, with a load of 8,230 tons, corresponding to a draft of 24 ft. 6¾ in. in water of 0.013 density. The fuel-consumption measured during a three hours' trial corresponded to 9½ tons per day, but it is expected in actual operation the daily fuel-consumption will be about 8½ tons.

The engine-room crew will consist of four engineers, three assistants, three oilers and two firemen—the latter being for the donkey boiler supplying steam to the cargo pumps for discharging. Each main engine with thrust block, but without propeller or shafting weighs 132 tons, and the total engine-room weight including propellers, shafting and auxiliaries amounts to 414 tons. The vessel will be operated by the Italian Navy.

Spanish Government Vedette Boats

In order to combat the smuggling of tobacco into Spain, the Spanish Tobacco Monopoly (Tabacalera) received authorization to build a certain number of chasers for this purpose, and as a commencement it decided to build 15, of which six, ordered in September, 1922, are now ready and the rest, ordered in December, 1922, are under construction.

These boats are built of steel to the following dimensions:

Length	65 ft. 0 in.
Max. breadth	11 ft. 4 in.
Depth	4 ft. 8 in.
Max. draft	3 ft. 6 in.
Displacement	29 tons

Each of these vessels is fitted with a 160 b.h.p. four-cylinder direct reversible Bolinder engine, turning at 350 r.p.m., giving the boat a speed of over 12 knots. The propeller has a diameter of 4 ft. and a pitch of 4 ft. 6 in. with a blade area of 4.14 sq. ft., has 3 blades and is made of bronze. Fuel consumption is approximately 0.55 lb. per b.h.p. hour with an oil of 0.875 specific gravity and 158 deg. F. flashpoint.

The engine is fitted with two water-cooled silencers, from each of which an exhaust pipe is led to a separate funnel, one on each side of the boat's deck-house. The funnels can be let down and are arranged as auxiliary silencers, for which reason the boats run very silently. For starting purposes the engine is furnished with an electric ignition device which has operated very satisfactorily, allowing a start to be made at a moment's notice.

Profits From Motorships

When the East Asiatic Company was formed in Copenhagen 26 years ago, the organizers stated that the stockholders might reckon on a dividend of about 8% per annum. The company was so well managed that the average dividend during the first 18 years was 8¾%, while over the first 25 years of operation the dividends have averaged nearly 23%. Furthermore a reserve fund equal to 125% of the capital has been created. This was the company that put the motorship on the ocean. When its extraordinary prosperity is considered in conjunction with the outstanding activity of the motorship and Diesel engine departments of Burmeister & Wain and of Harland & Wolff, one is left with the impression that it is profitable to get into the motorship business on a big scale.

For the first time an oil-engine is being used in life-saving service. The new lifeboat DORIS RIJKERS, built for service in Holland, is propelled by a four-cylinder Brons type of engine built by Deutz, the type of engine better known in this country as the Hvid. This boat, which is 59 ft. in length, 14 ft. 5 in. in breadth and draws 3 ft. 11¼ in., has a displacement of 40 tons. She has been put into service by the North & South Holland Life Saving Institution. The Kromhout engines in this vessel embody new devices of which much is expected.

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Diesel Yacht For J. W. Kaiser

New York Yachtsman Orders a 156 Ft. Boat With 600 H.P. to Make 14 Knots Speed

A large Diesel cruising yacht has recently been contracted for, which in some respects is a departure from the types recently built or now under construction. The owner has been particularly anxious to secure a good-looking boat, without sacrifice of strength, stability, seaworthiness, or comfort, and the designers have in this new yacht produced a vessel of very pleasing appearance embodying a full measure of the other requirements.

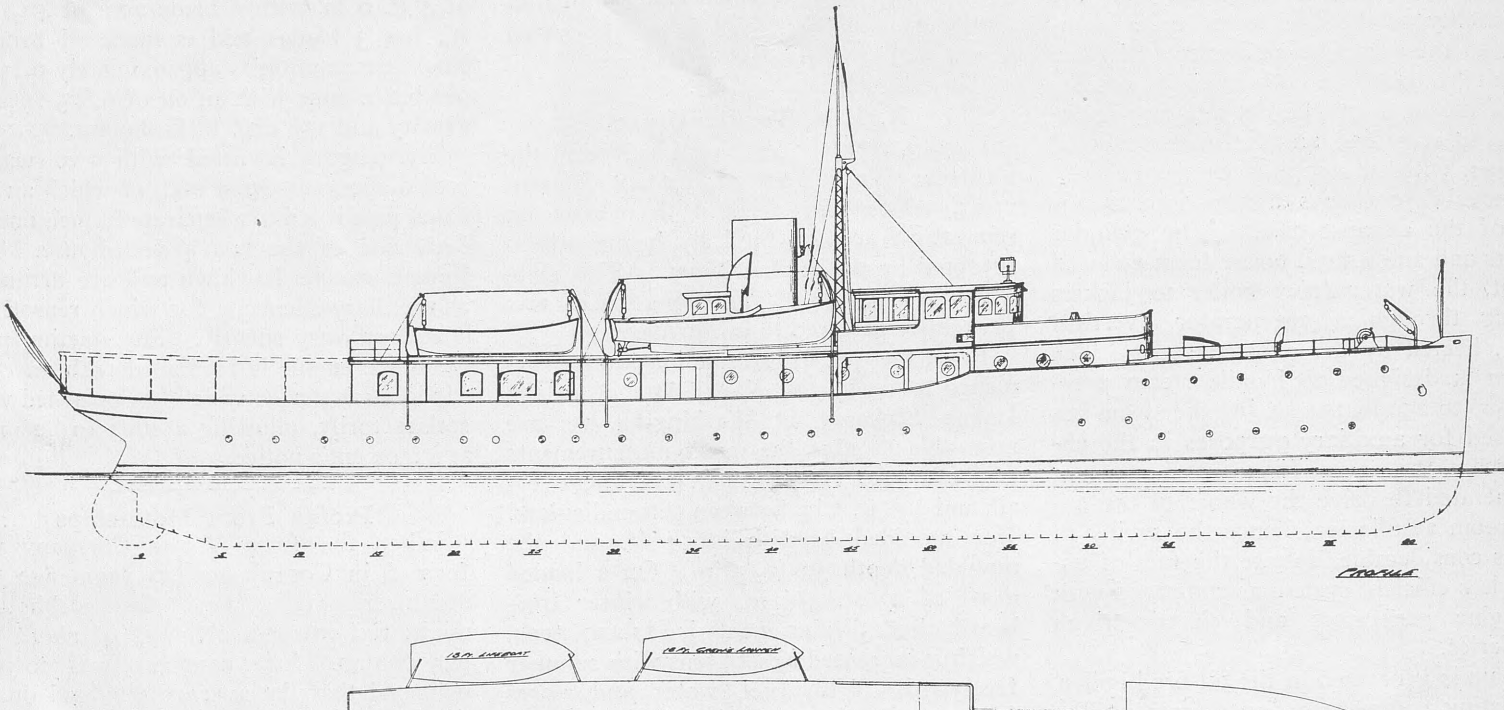
OCEANUS, as the new yacht will be named, is for J. W. Kaiser of New York:

Length overall..........156 ft. 4 ins.
Length on waterline......149 ft. 2 ins.
Beam ....24 ft. 6 ins.
Draft, fully loaded.......9 ft. 4 ins.

Two six-cylinder Krupp Diesel engines developing in excess of 300 h.p. each at moderate revolutions will provide the motive power. With the full power of the machinery, the OCEANUS will make a speed in the neighborhood of 14 knots, and at sea will cruise easily in excess of 12 knots. A fuel oil capacity sufficient for a steaming radius in excess of 6,000 miles has been provided.

This new vessel is of the flush deck type, with rather straight shear, having a long continuous steel deckhouse and a raised forecastle, both for the purpose of giving additional freeboard forward and permitting a double deck arrangement, which increases the size of the quarters available for officers and crew. There is a large funnel directly amidships having little or no rake, and just forward of this is a high military mast of lattice steel construction. This arrangement, associated with the nearly straight stem and moderate overhang aft, produces a very smart effect, all the lines being graceful and the vessel, although really having considerable freeboard, not appearing unduly high above the water.

Another feature adding largely to her appearance is the manner in which the flying bridge and pilot house on the upper deck have been treated, this part of the vessel having been handled in a most attractive way. The regular enclosed bridge has been fitted, which is in keeping with the general design and will provide good pro-



Plans of the motoryacht *Oceanus*, building for J. W. Kaiser of New York, and to have twin 300 shaft h.p. Krupp Diesel engines

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tection for those in charge of navigating the yacht.

On the berth deck, forward of the engine room bulkhead, there is a large refrigerator space on the starboard side, divided into compartments for meat and vegetables. The messroom for the officers and a separate messroom for the crew, as well as the laundry, are also on this deck. The crew proper is housed in the lower forecastle, where they have excellent accommodations including their own toilet space. The officers are very comfortably housed in separate staterooms in the upper forecastle.

For the owner and his guests the general arrangement of the quarters follows the idea which Cox & Stevens have developed and used in so many of the successful cruising vessels. It includes a long continuous deckhouse on the upper deck, in which are placed the various public rooms, and an arrangement of the staterooms in which the owner's quarters are separated from those of his guests and served by an independent stairway.

In the deckhouse the architects have placed the dining room at the forward end, the galley and pantry being on the same deck, directly aft of the dining room. An inside passage runs aft on the starboard side from the dining room, past the pantry and galley and the engine room enclosure, ending in a door at the after end which opens into the living room. From this passageway there is a stairway just forward of the engine enclosure going up to the pilot house and chart room, and another stairway at the after end of this enclosure leading below to the owner's staterooms.

Between the engine room enclosure and the living room is an attractive library and a deck toilet. The living room is of large dimensions and has three windows on each side, the center window being unusually large. This arrangement, while supplying ample light, has been worked out so that there will be good wall space to relieve this room from the criticism so often and properly made that there is too much window and too little wall space in the average room on a yacht. At the after end of the living room is a door opening into a lobby or entrance which contains the stairs to the guests' quarters below on the berth deck, and also a stairway from the after deck to the boat deck. In addition, at the after end of the deckhouse there is the usual enclosed deck shelter space in order that in bad weather those on board may enjoy the fresh air without having the discomfort of being on the open deck.

From the after end of the deckhouse to the stern there is a large space of clear flush deck, and the stern seat has been arranged to form in reality three upholstered settees, making a very useful and comfortable lounging space.

State rooms for the owner and guests below have been worked out with six large rooms and five bathrooms, each room having ample wardrobe space as well as drawer space in the furniture. The bathrooms are all of ample dimensions. The owner's private stairway from the main deck ends on the berth deck in a lobby amidships, from which the two owner's staterooms, both of which are large and intercommunicating, are reached. Each of these rooms has a separate bathroom forward of it, which, together with the arrangement of wardrobes and lobby, provides an insulating space between the stateroom and the engine room, which will have the effect of eliminating any engine room noises from these rooms. The stairway from the lobby on the main deck lands on the berth deck in a passageway on the centerline, around which passageway are grouped the various staterooms and bathrooms for the guests. At the forward end of this passageway are two large double staterooms, each with a bath adjoining; at the after end of this passageway is a third double stateroom with an adjoining bath, and on the port side of the passage at its after end is a single guest's stateroom, and on the starboard side adjoining the stairway is a large linen locker.

All of these rooms have at least two air ports, ample floor space, are heated—as is the whole ship—by hot water, and in addition are supplied with fresh air from a forced ventilating system, which permits the rapid change of air in the room when at sea and when all air ports and other openings are closed.

The equipment of this vessel will be unusually complete, no expense having been spared to provide whatever is necessary for a vessel of her type and size. All the auxiliaries are driven by electricity, and the boats are hoisted by a specially designed electric winch. The equipment of boats includes a 25 ft. owner's launch with coupé body, an 18 ft. crew's launch, two 18 ft. life boats, and a dinghy.

The placing of the contract for this new yacht is a further evidence of the fact that owners and architects alike are convinced that the Diesel engine is the only power that should be installed in new vessels of moderate size and speed. Their use has made possible the construction of craft such as the OCEANUS, which on moderate dimensions, with a small crew, will provide equal comfort, more accommodation, and less operating expense than could possibly be secured on a steam driven vessel of considerably larger proportions.

The Diesel engine has gone beyond the experimental stage for yachts, and its reliability has been demonstrated by such vessels as Vincent Astor's NOURMAHAL, and E. W. Scripp's OHIO, both of which have made extended cruises, the OHIO having recently crossed the Pacific, making a record voyage both as regards time and comfort to those on board.

The Question of Superintending Engineers

By A. B. NEWELL

The American motorship in coming has traveled a rough road. Her delayed arrival has ever been the fault of men in some way connected with her construction or operation. Sometimes the machinery was at fault and sometimes the ship, but far more often the trouble lay in operation after completion.

No doubt operating engineers, through their inexperience, did much harm, but they were severely criticized, and the truth went home where it hurt, but helped. At present little is being said about them, which indicates that there is little bad to say, for critics are prone to speak when there is a fault to find and often remain silent when praise is due. The present silence then speaks well for the operating engineers.

Since the American motorship has arrived, we must not be led to believe that hers is to be a path of roses hereafter. There will be many a bump and rut for her to negotiate, not the least of which will be the lack of knowledge and indifference of men who have their own, as well as the ship's welfare at stake.

Where superintending engineers relieve operating engineers of the responsibility of making important decisions with regard to methods of operation, it then behooves them to be well versed in the requirements of oil-engine driven vessels. In connection with steamships they often use their abundance of knowledge to advantage, but when they are confronted with the operation of motor-vessels they may not be so capable. Unfortunately many of them cling to what they think are conservative methods; graduates of the old school, they allow unreasonable prejudice and excess caution to influence their movements. Some may have attained a smattering of knowledge of motors, while others have gone into the subject thoroughly, but as yet there are very few of either.

Some may find themselves in deep water and hope to get out by passing the buck, but such methods will never do. They will merely get further beyond their depth, for no man ever went far by way of bluff. They will learn—time permitting—that a study of motors and their requirements in connection with ship propulsion is the only thing which can help them.

When a superintending engineer finds himself taking over the responsibility for the operation of a motorship and a lingering doubt remains in his mind as to whether it will be a success, when he feels that possibly steam would have served better, when he thinks that he will be able to pick up enough to get along, or when he supposes that someone else will give him the important information which he needs and he is not quite sure that he will be able to grasp the whole thing; then before long he will drop a nut in the gears and something will go smash, which will constitute another bump or rut in the road of the American motorship. Such bumps and ruts will be smoothed out in time, regardless of their magnitude.

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Various Oil Engine Trials and Experiments*

A Resume of Some Interesting Trials Carried Out on a Scott-Still Combination Oil and Steam Engine

By A. I. NICHOLSON, B.Sc.

THE success of any engine being dependent upon the solution of the numerous problems in its design and construction, the purpose of this article is to record some experimental results upon certain details met with in oil engine design, in the hope that they may help to illuminate some of the more elusive elements. The experiments which form the subject of the article were carried out on a combined oil and steam engine, but they have been specially selected and presented with a view to their being of value and interest to oil engine designers and users in general. The engine referred to was an engine working on the Still principle and known as the Scott-Still engine. It was designed, constructed and tested by Scotts' Shipbuilding and Engineering Company, Greenock, Scotland.

Before giving the results of experiments that were carried out it may be well to refer briefly to one or two features connected with the experimental gear.

The engine, with all its necessary fittings, pipes, and auxiliaries, was erected on the test bed, and the power was absorbed and measured by a Froude dynamometer, which was found to be a very satisfactory instrument.

Fuel was measured by drawing it from graduated tanks. Two were provided, one being in use at a time. The calibration of these tanks was checked more than once to ensure accuracy. A method of weighing the fuel oil was tried, but the readings obtained did not appreciably vary from those obtained from the calibrated tanks. The drawback to calibrated tanks is that allowance must be made for the temperature of the oil in the tank and for its specific gravity. On the other hand, calibrated tanks are easy to manipulate.

A variety of indicators were used at different times, including a Hopkinson flashlight indicator. The indicator gear fitted was of the lever reduction type, designed to give a mathematically correct reduction. Ground case-hardened pins and bushes were used throughout, and a heavy spring was applied to the end of the lever to eliminate any reversal of load upon the bearings.

It is very difficult to eliminate errors from combustion indicator cards. Very slight slackness in any part of the gear, say, in the indicator drum, in the indicator, in the driving levers, cords, or links, makes a considerable difference. The area enclosed in the card is very small, and so crowded to one end of the card that very slight inaccuracy arising from any one of a combination of the above elements affects the results obtained.

Inertia of the parts also tends towards inaccuracy, and even at low speeds it is found that inertia has an effect. The temperature and general conditions to which the indicator pistons are subjected call for frequent cleaning of the indicator, and the more frequently this is done the better. From considerable experience of indicator cards and the process of taking them, it is suggested that oil consumptions guaranteed upon a basis of indicated horsepower should never be accepted.

It was not always possible during the trials upon the engine to adhere to the excellent experimental rule of altering one variable at a time. In some cases a number of variables were interdependent, and variation of one affected all the others. There were occasions, too, when it was inexpedient to vary one thing at a time, for the whole purpose of the experiments upon the engine was to make the engine workable, reliable, and commercially competitive.

In the results which are presented comparisons have been made between figures taken under conditions as closely comparable as possible in every case. In an experimental plant of a size where a number of men are required to run it, inconsistent readings can hardly be avoided, while mechanical changes often creep in.

In some of the curves that follow, the results are based on oil per hour per brake horsepower, because this is considered to be the most reliable and the most satisfactory basis for an engine of the type. The brake horsepower used throughout was the power measured at the dynamometer, without allowance for any scavenging blower power. The results given represent what the engine was doing under the conditions existing at the time, and are in no way representative of the best that could be done, but, as mentioned above, each set of results is as closely comparable as possible.

The following subjects will be considered:

1. Leakage of oil at pump plunger packings.
2. Mechanical efficiency and engine friction.
3. Fuel injection experiments. (a) Atomisation of fuel. (b) Penetration of air charge by fuel jets. (c) Distribution of fuel in the air charge. (d) The relative importance of these factors.
4. Detonation.
5. Scavenging as affected by piston shape.

Leakage of Oil at Pump Plunger Packings

As it was considered desirable to try to eliminate packing from the fuel pump plungers, and as the fuel injection pressure to be used was high, it was decided to construct a test gear on which experiments upon the leakage past plungers without packing could be carried out.

It was regarded as essential to have the plunger reciprocating, and as there was little power available it was decided to have two pistons, attached the one to the other and moved in and out together. This eliminated all unbalanced load due to fluid pressure, reduced the work to be done, and made the movement of the piston a simple matter. A belt and pulley drive was used, and on the pulley shaft was fitted an eccentric which pressed upon the piston end, pushing it in, while a spring returned it.

The first tests were made with ground steel case-hardened plungers, and cast-iron liners reamed to size. The fits were not so good as were obtained in the second series of tests, when a shorter cast-iron liner, referred to as B2, was used with the hole ground to size. The first liner was 12 inches long. The second liner was ground over a length of 4½ inches, or 3.13 times the diameter (which was $1\frac{7}{16}$ inch), and it was made so that it could, when reversed, be under entirely different pressure conditions (as will be understood from a later reference).

The following indicate the fits that were measured at the end of the tests:

Plunger	1.437 in.
B1-reamered liner	1.439 to 1.441 in.
B2-ground liner	1.438 in.

Tests of leakage of oil and of the spring load required to return the plungers were made with the plungers running, and also with the plungers stationary. Except for the stationary test, all the tests were made after having run the gear for 84 hours. The same plungers were used throughout, i.e., with the two types of liners. The running speed was 132 double strokes per minute, equivalent to a main engine speed of 132 revolutions per minute.

Two oils were used—a heavy oil of 0.945 specific gravity at 52 degrees F., and a kerosene having a specific gravity of 0.81 at 52 degrees F. A hand pump and a high-pressure air bottle were used to maintain the desired pressure for the tests.

Test Results—A series of eight curves were obtained representing the leakage measured in fluid ounces at different pressures of oil in the pump casing. Kerosene had a higher leakage than the heavy oil, and a groove was cut in the liner to test its effect. The effect of this groove was to increase the leakage.

The liner was next reduced successively to 10 inches and 7 inches in length, and tests made to compare the leakage. The two inches and three inches were removed from different ends. During this test a hole, which was drilled into the groove in the liner already referred to, was closed by a presser gauge. The leakage increased as the length was reduced.

The second liner with which the remaining tests were carried out was in every way a better job, the casting and machining being better, the short length making accurate machining easier. The leakage with this ground liner was substantially less than with the other. Also, it was noticed that the leakage increases with the pressure and then decreases, suggesting that the liner is being closed upon the plunger at the higher pressures. This seems to be very

*Abstract of paper read before the Institution of Engineers and Shipbuilders in Scotland.

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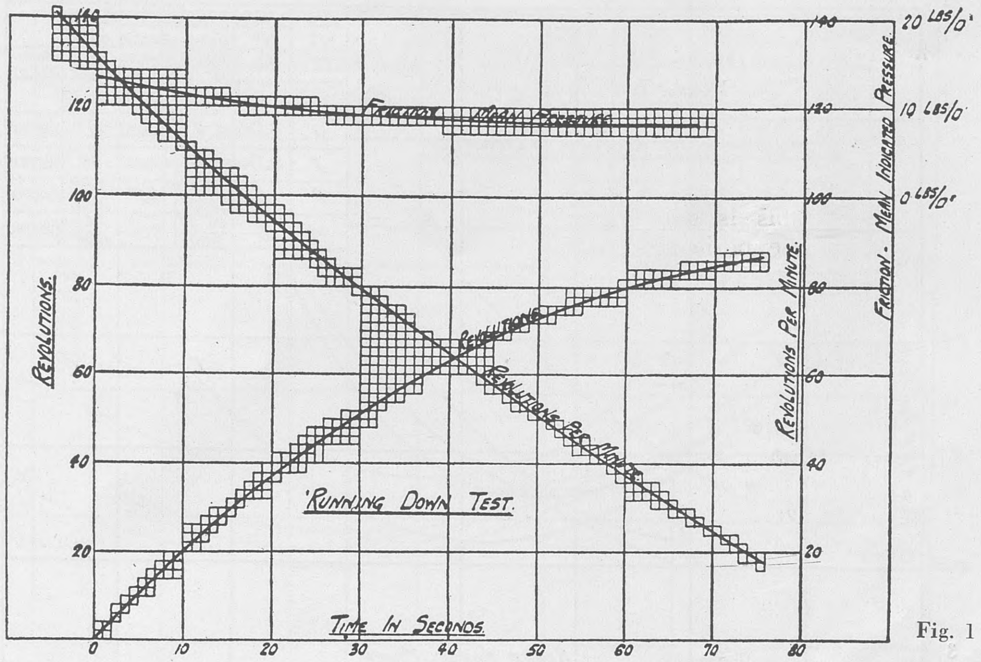

Fig. 1

likely, for the outer diameter of the liner is subjected to the fluid pressure, while the inner surface, in contact with the plunger, is subjected to a considerably smaller pressure depending upon the amount of leakage between the liner and the plunger. At the same time the outer surface is 2.44 times the inner surface, so the crushing pressure may be considerable. To settle this point the liner was inserted in the casing in the reverse direction, i.e., end for end. When in this position there was no opportunity for the liquid to close the liner upon the plunger. The result proves this conclusively, for the quantity of leakage was considerably more, being fully eight times as much at a pressure of 2,000 lbs. per sq. in., while at 3,000 lbs. it would have been many times more than it was before reversing the liner. A test of the leakage of the plunger when stationary was made, and the leakage was almost half that when the plunger was moving.

Tests were made to determine the friction of the plunger in the liner or packing. This was done by measuring the minimum compression required on the spring to keep the plunger on the cam. The friction was taken as the load on the spring when the plunger was at the outer end of its stroke. The ground liner, i.e., the more accurately fitting liner, had a greater friction than the reamered liner, even though it was of shorter length; but a plunger fitted with special white-metal packing rings had the greatest friction of all. It may be mentioned, however, that the leakage with the white-metal packing was almost negligible, though the packing process was a very lengthy one.

As a result of these experiments the fuel pump fitted upon the experimental engine was constructed with a liner similar to B2, as the leakage was found to be small, and with proper collecting arrangements little or none of it need be lost. At the same time the friction of the plunger in the liner was small, and fairly definite in amount. Tests of the leakage upon the actual pump with liner and pump plunger based on the above results showed that the leakage was less at 5,000 lbs. than at 2,000 lbs. per sq. in.

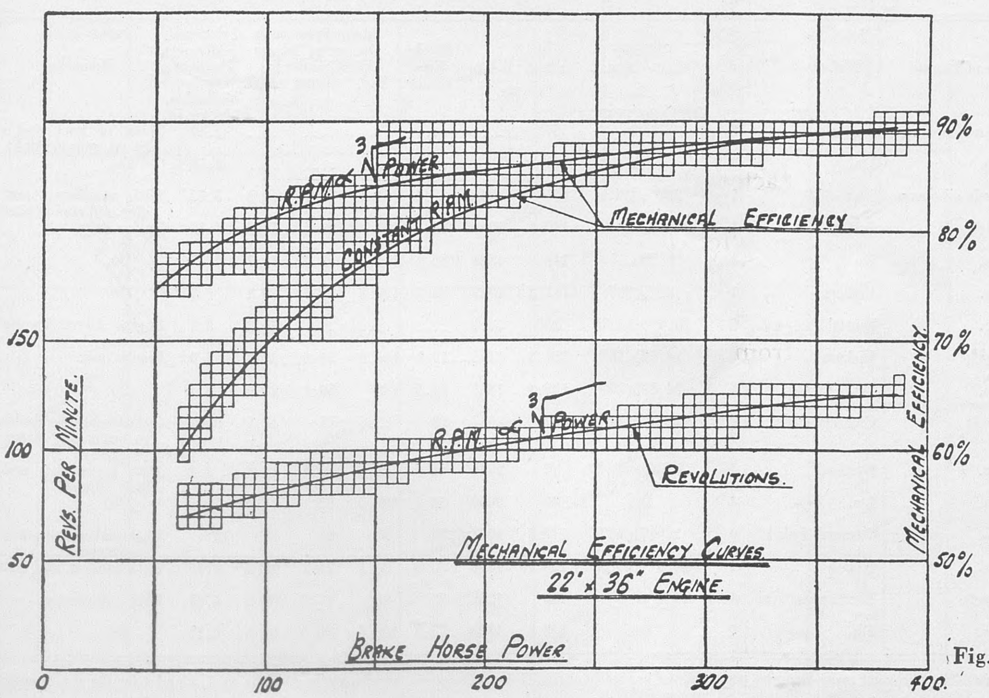

Fig. 2

Mechanical Efficiency and Engine Friction

The power absorbed by any machine in simply driving it round is a very important factor in fixing the efficiency of the machine. No matter what the power developed by the machine may be, the effective power output is what remains after deducting the frictional horsepower. In reciprocating engines, where there is a considerable number of rubbing surfaces, the loss from friction is considerable, and in oil engines, where the piston surfaces play a large part in causing the losses, the mechanical efficiency is lower than in steam engines. The losses can be fairly readily determined from reciprocating engines when the brake horsepower is known, for the indicated power can also be determined.

It appeared from a number of results on the engine under consideration that the frictional torque, or the friction expressed in terms of a pressure per sq. in. of piston area, changed slightly with the revolutions, and it did not appear to change much with the load in the engine. It seems very probable that the same will hold for all oil engines, when auxiliaries such as air compressors and scavenging blowers are excluded. This is, therefore, a very convenient figure to determine for any engine, since, from it, the horsepower absorbed in overcoming the mechanical friction of the engine at any speed can be determined.

In the case of the experimental Scott-Still engines, there were two ways available to determine the frictional mean pressure, namely, by running the engine light on steam only, or by comparing the brake power with the indicated power.

The figure so obtained represents the power absorbed in the main engine bearings and piston, in the auxiliary engine bearings and piston, and in all the pumps driven by the engine, namely:—regenerating circulating pump and fuel injection pump for the oil side; the air pump, feed pump and high-pressure valve-gear pump required for the steam side; and in the windage of the flywheel. The existence, therefore, of these extras about the engines lowers its mechanical efficiency, but the effects of all of these are included in the figures following. A third method was also adopted as a check upon the others. The engine was put up to full speed, then every source of external power was shut off, and counter readings taken every few seconds. From these results, knowing the moments of inertia of the rotating portions of the engine, it is possible to deduce the engine friction. Steam cards gave a frictional mean pressure of about 10 lbs. per sq. in. of piston area calculated as acting during the combustion stroke. That is if the indicated mean pressure were 90 lbs. per sq. in. the brake mean pressure would be 80 lbs. However, as an average from a great many readings, the engine friction with the engine on load was found to vary from 8 lbs. at 70 r.p.m. to 11 lbs. at 130 r.p.m.

Running-Down Test—In Fig. 1 is plotted one set of readings from a stored energy, or running-down, test carried out under the conditions previously referred

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to. From this, by graphical differentiation, a revolutions-per-minute curve has been obtained, and from the relationship that

$$\text{torque} = \frac{I \times w}{g}$$

where I=moment of inertia of the rotating weights of the engine in lb. x ft.^{2}, and w=angular retardation in radians per second^2, it is possible to determine the frictional mean pressure in lb. per sq. in. of piston area over the range of the test. The friction curve so deduced is also given. It will be seen that this gives values varying from 13 to 8.25 lbs. Great accuracy cannot be obtained in the ordinary course in a test of this kind, for the revolutions read from the counter are to the nearest whole number only. The results are, however, reasonably in agreement with the figures deduced from indicator cards.

Mechanical efficiency curves have been plotted in Fig. 2 for:—

(1) Constant revolutions (as for electric generating engines). In this case the revolutions per minute equal 120.

(2) Revolutions varying as the cube root of the power, i.e., approximately in accordance with the variation of revolutions and power on board ship.

These curves have been constructed on the basis of frictional mean pressure given above. It will be seen how quickly the mechanical efficiency falls off at low powers when the revolutions are kept constant.

In Table 1 some trial results of several types of engines have been collected to show the losses due to mechanical friction. It will be seen, for example, that there is little difference in mechanical friction between four-cycle and two-cycle engines.

Fuel Injection Experiments

Before referring to some of the experiments carried out in connection with the injection of the fuel into the cylinder, a few explanatory remarke may be made upon the system employed.

Airless fuel injection was the system in use, that is, the oil was injected under direct pressure and not blown in by air. One fuel pump was used for the cylinder, so arranged that it discharged only during the injection period. The pump was driven by a cam on, or connected directly to, the crankshaft. The fuel valve was of automatic type, opening whenever the oil pressure reached a certain predetermined amount and closing whenever the pressure fell to a definite amount. The pump was of ample capacity to discharge from two to three times the amount of oil necessary, and a combined relief and spill valve was fitted in the oil discharge system, so that any desired amount of oil might be allowed into the combustion cylinder, the remainder being automatically relieved by the valve opening under pressure, and/or finally spilled from the system by the valve being positively lifted off its seat. Given a certain form of cam and a fixed size of pump plunger, the rate of pumping was fixed when the revolutions per minute were fixed.

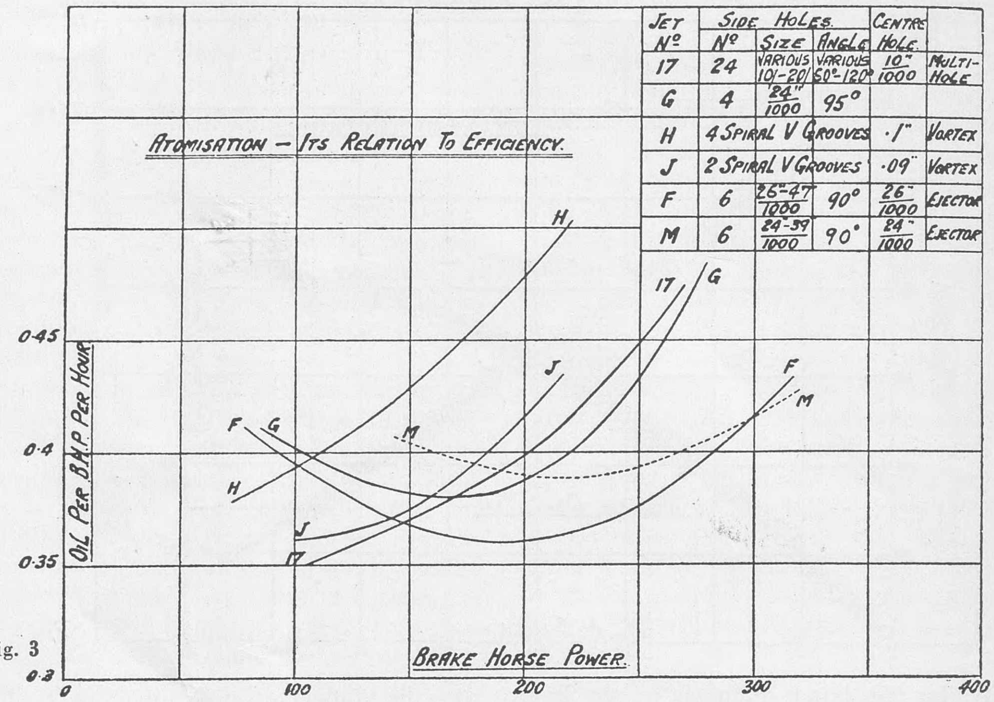

Fig. 3

The rate of injection of the fuel into the cylinder depended upon the rate of pumping, but was not necessarily equal to the pumping rate, because of the existence of the relief valve on the system. In reality the rate of injection depended upon the area of the oil fuel spray holes and the mean oil pressure maintained at these holes, and the period over which it was maintained. The determination of the oil pressure in the system was very difficult, for the whole injection process occupied only about 1/25 second, and the rise in pressure from zero to about 6,000 lbs. per sq. in. took place in about 1/40 second. Attempts were made to find out the maximum pressure of injection, and readings were secured, but one would not care to guarantee their accuracy.

A little consideration of the features inherent in the system of injection under which the following experiments were carried out, will show that in some respects the system is not a very suitable one for experiment, as it is almost impossible to change one variable at a time, since the variables are all more or less interdependent. The results following should, therefore, be considered in the light of the above explanatory remarks regarding the system of injection. For instance, every change made, as, for example, in the size of spray holes, had some small effect on the period of injection and the pressure at which the injection of the oil took place. Slight changes in these factors were found to have little effect upon the combustion, and thus may reasonably be neglected. It may be useful, in forming some idea of the injection process, to consider how much fuel oil was pumped into the engine cylinder during each stroke when at full power. Taking about 120 lbs. of oil per hour, the equivalent volume of oil injected each revolution amounted to 0.5 cub. in., or the equivalent of a spherical ball one

TABLE I
Typical Friction Mean-Pressures for Various Engines

Type of Engine	Maker	No. of Cyls.	Cylinder Dimensions	r.p.m.	B.h.p.	Mech. Efficiency	Mean-Pressure in lbs. per sq. in. per Working Stroke			Frictional Mean-Pressure per Str. of Engine. Lbs. sq. in.	Remarks
							Ind.	Brake	Diff.		
Double acting-steam	Scotts	3	$\frac{16''+26''+42''}{27''}$	57	....	....	....	....	....	1.89	Mean of port and starboard, running light.
Do.	Do.	3	Do.	162	....	....	....	....	....	2.13	Do.
Two-cycle oil-steam	Scott-Still	1	22″×36″	125	345	87.4	91.4	79.9	11.5	5.75	With auxiliary steam engine and engine pumps.
Two-cycle	Sulzer	1	39.4″×43.5″	149.9	1791	86	104	89.4	14.6	7.13	Engine only.
Do.	Do.	1	Do.	148.8	1986	89.5	111.5	99.75	11.75	5.87	Do.
Do.	Vickers	1	30″×36″	141.2	1042	92.5	124.1	114.7	9.4	4.7	Do.
Do.	Scotts'	6	13.8″×14.2″	350	....	....	....	....	10.2	5.1	Engine driven by electric motor.
Four-cycle	Vickers	12	14.5″×15″	381.3	1215	79.9	106.2	84.9	21.3	5.3	Engine only.
Do.	Do.	6	24.5″×39″	119.8	1338	78.5	102	80.1	21.9	5.5	Do.
Two-cycle	Cammell-Laird	4	18½″×50″	117.3	1037	83	....	65	13.3	6.65	Including mechanical losses in scavenging pump and compressor.
Do.	Doxford	4	22.75″×90.5″	80	2730	84.8	108.2	91.8	16.4	8.2	With scavenging and engine pumps.
Do.	Do.	4	Do.	60	2050	86.5	106.5	92	14.5	7.25	Do.
Do.	Cammell-Laird	4	18½″×50″	117.3	1037	83	89	65	24	12	With scavenging pump and compressor.
Do.	Nobel	4	26.6″×36.2″	105.4	1590	80.5	92.1	74.2	17.9	8.95	With comprs. and blower.
Four-cycle	Beardmore, Tosi	6	24.4″×	124	1267	77	98	75.5	22.5	5.63	With compressor.
Do.	Do.	6	Do.	129.6	1332	75.5	100.5	76	24.5	6.12	Do.

Note—The frictional mean-pressure per stroke of engine is obtained from the previous column by dividing by 1, 2 and 4 for the steam engine, two-cycle oil engine and four-cycle, respectively.

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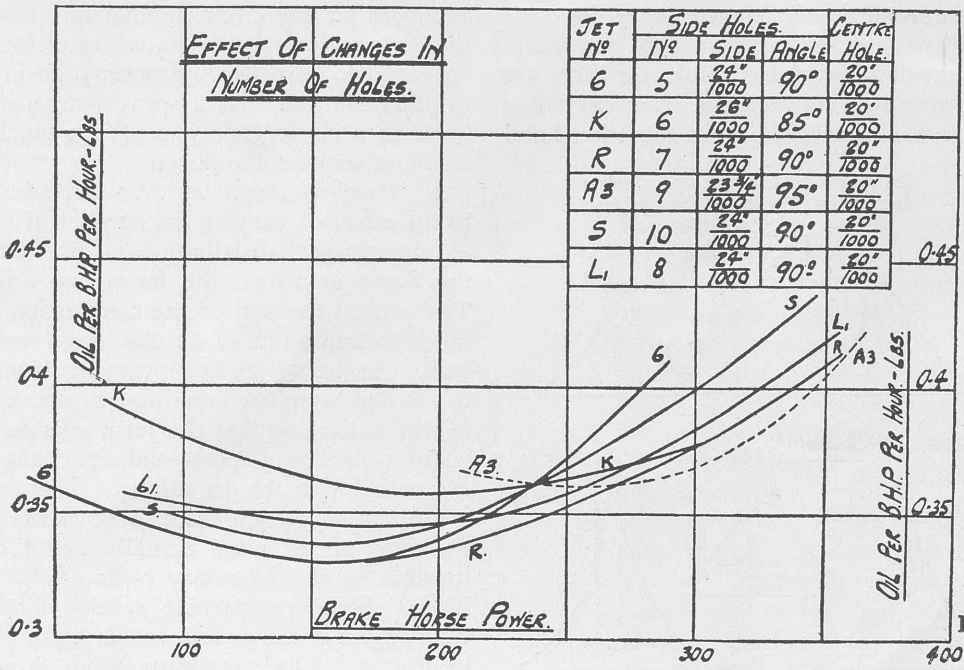


Fig. 4

inch in diameter. If this were injected through eight holes of 24/1000 of an inch diameter, the equivalent jet length for each one is about 11½ feet. The usual period during which the fuel valve was open was about 20 degrees of crank angle, and the full open period was about 13 degrees, or, say, 0.018 second at 120 r.p.m.

(a) ATOMISATION OF THE FUEL—The first jets tried had spray holes of 20 mm. diameter, and for some time after the tests began no other means of atomisation than by small holes and high pressures were considered. The results, however, that were obtained in the first set of trials were not very promising, and new means of atomisation were considered.

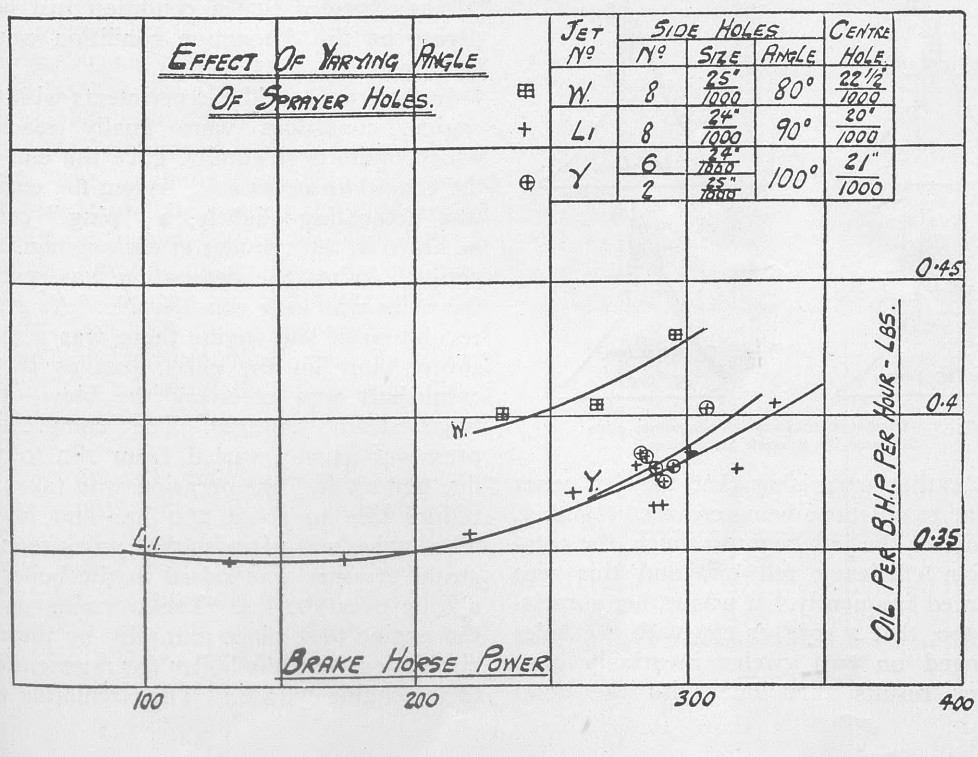
1. *Voster or Whirling Sprayer*—Boiler-oil fuel burners are known to atomise the oil under very low pressures, and the principle on which these worked is to "whirl" the oil. It was not expected that with the spasmodic discharge of the engine very good atomisation would occur with such a jet, but on trying a spray orifice having part of a helical groove cut in it, excellent results were obtained in the open. It had become customary to test all sprayers in the open before trying them in the engine, and the tests with a plain hole sprayer showed that the jets were atomised finely at the circumference, but had a core of unatomised oil. A candle held in way of the sprays might be extinguished, and very seldom would set the oil alight. A torch would set it alight, but the combustion was rather leisurely. On the other hand, a vortex or whirling sprayer gave an exceedingly fine cloud of oil, which flatted up into the atmosphere above the valve. A candle held in this spray set the whole off quite violently. The atomisation obtained was far ahead of what was obtained with the plain hole sprayer and was practically perfect. It was, moreover, obtained with a relatively large passage through the cap, and this alone was a feature of considerable value, for it meant that the chances of a stoppage, due to particles of dirt lodging in it, were negligible compared with the chances where holes of 20 or 25 mm. are used. It may be mentioned that it was the rarest thing, after the first few runs and the adoption of proper precautions, to have any sprayer holes clogged or stopped. When tried on the engine the results given by this "whirling" spray were poor and disappointing, for high loads could not be carried, though at low powers the results were quite good.

2. *Ejector Sprayer*—A further device tried was what may be termed an ejector sprayer. Atomisation requires energy to produce it. It was thought that it might be possible to get an additional source of energy by starting combustion of the oil within the sprayer. An ejector can be made to draw in from the surrounding space, and by fitting a combining tube with an expanding nozzle it is possible to deliver against a moderate back pressure. It was thought that by making a jet of oil draw in hot air from the cylinder, combustion might start in the combining tube and the energy therefrom would assist in discharging the jet from the nozzle and give both better atomisation and better distribution of the fuel in that combustion space. Two such sprayers were made, the result being a very fine piece of workmanship. In the open they sprayed very much like plain hole sprays, but it was impossible to know if they were functioning as ejectors. In the engine their behavior was not in any way distinguished from plain hole spray orifices. It was noticed that the air inlet holes were quite clean after use, indicating that at least no oil was being discharged there, and suggesting that they were probably drawing in a little air. The results, however, were not promising enough to warrant further experiment.

3. *Small Hole Sprayer*—A very fine hole sprayer was made and tried, to determine further the benefit of extreme atomisation. In addition, this spray had a large number of holes. The results were very much the same as the better of the whirling sprayers. Fig. 3 shows the results of these several sprayers.

(b) PENETRATION—Varying Sizes of Sprayer Holes—The oil which is injected into the cylinder must, in the first place, be atomised to some extent to facilitate combustion. It must also be well thrown into the air space to reach the air available. It is essential that as much of the air in the cylinder as possible be "interested" in the oil, for there is no time for any leisurely process of combustion to take place. Unless there is turbulence in the combustion space the air will not come to the oil, so the oil must go to the air, that is, the oil jets must penetrate well into the furthest recesses of the combustion space. The ability of a jet to penetrate through air at a pressure of 300 lbs. per sq. in., and about eight times as dense as the atmosphere, depends upon high speed, bulk and compactness.

High speeds call for high pressures, and high speeds are favorable to atomisation. A large diameter jet travels further than a small diameter one, but is more difficult to



atomise completely. A jet that is breaking up or atomising is not a good "projectile"—a non-atomising jet goes further. Atomisation and penetration are directly opposed, and the practical question, therefore, is: Which is the more essential for good combustion? In the preceding section it has been seen that extreme atomisation alone is of no value. Trials were made with sprayers having eight holes in each case, but with diameters varying from 20 to 24 mils. At 210 b.h.p. there is little to choose between the results of these, but as the load increases the 24 mm. jets have the advantage. Even at light loads they show up better. This latter is hardly what would be expected. At 300 b.h.p. and over the failure of the small jets to get at the air in the cylinder is evident. More surprising, perhaps, is the importance of what seems a very small difference, namely, 20 to 24 mm. The area of a 24 mm. hole is, however, 44 per cent. larger than that of a 20 mm. hole, a difference which is quite substantial.

When considering these results it may be noted that an increase of area of holes such as this changes the pressure of injection, but this appears to have very little effect upon the consumption rate, and consequently the results on this figure are fairly comparable.

(c) Distribution of Fuel in the Air Charge—The effect of the penetrative power of the fuel jets has been discussed in the preceding section, but it is evident that closely allied herewith is the provision of an adequate number of jets to distribute the oil through the whole of the combustion space.

Many variations of sprayers were made to secure what seemed to be called for. Holes in the sprayer cap were varied in number from four to 25. The sizes of holes were varied from 10 to 31 mm. The The arrangement of the holes was changed from one outer ring of holes with a center hole to three rings with a center hole. The angles of the jets were changed from 80 to 110 degrees, i.e., the angle measured from jet to jet.

Changes in the height of the fuel jet body were made to get better distribution, while some sprayers were made projecting well into the combustion space and having holes directed upwards as well as downwards. An interesting feature of this latter may be mentioned in passing. It was feared that this sprayer would suffer from overheating due to its length, but on taking it out after a trial no evidence of overheating could be detected. Apparently the oil passing through it was sufficient to keep it cool. Some sprayers, having larger holes on the exhaust side than on the scavening side to suit the air space about the piston, were tried also.

1. *Varying Number of Holes*—Some results obtained with varying numbers of holes are shown in Fig. 4. These give the results with sprayers that are almost similar in all other respects. It will be noted that seven and eight holes are better than ten or five, at the high powers. Without any question five holes are not to be compared with seven after about 200 b.h.p. This is not a surprising result, for there are air spaces left between the jet cones when only five are provided. On the other hand

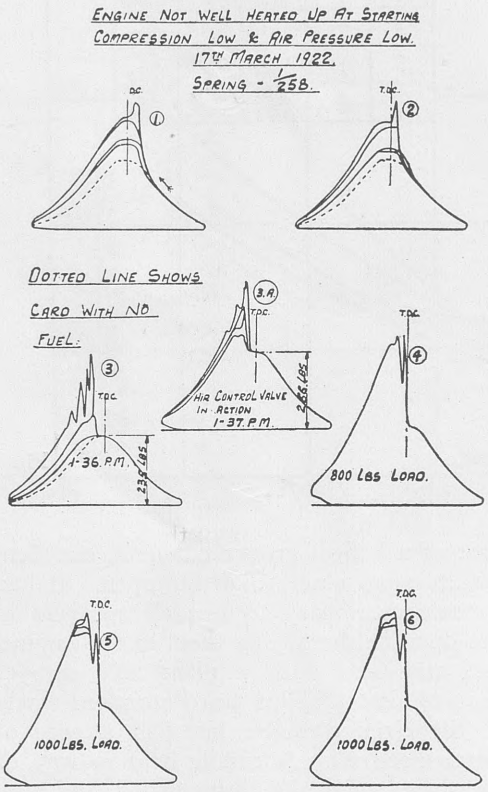


Fig. 6

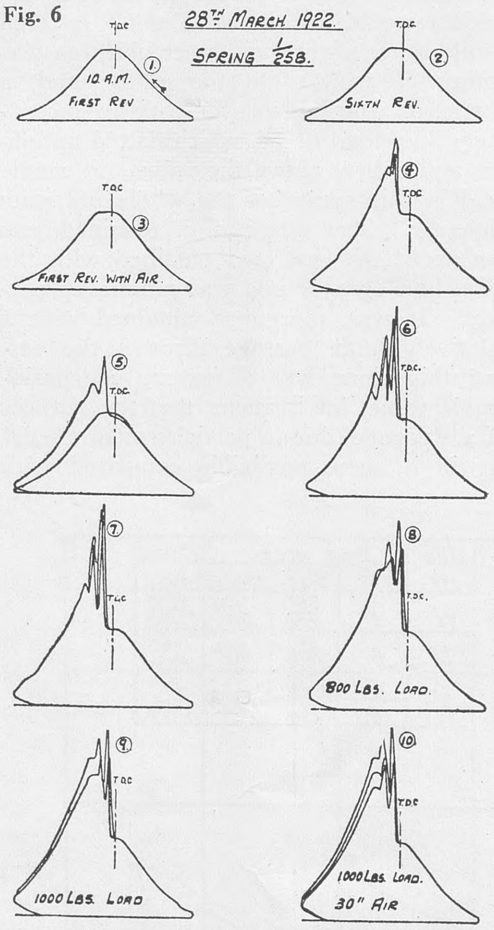


Fig. 7.—Displaced Indicator Cards taken when Starting Up to show Detonation.

it is rather surprising that the jet cones appear to object to being crowded together. Whenever the jets begin to touch, the combustion efficiency fell off, and this was observed frequently. It was rather surprising, too, that a sprayer cap with the holes arranged on two circles invariably gave poorer results than one with the holes arranged on one circle, though on drawing the distribution of the jets with the former appeared to be better. Examination in the cylinder showed that a sprayer with eight holes in a circle gave jets almost touching one another near the piston.

2. *Varying Angle of Jets*—In addition to the effect of varying the number of holes in the sprayer, distribution is affected by the angle at which the holes are drilled. The conical top end of the combustion cylinder had an angle of 62 deg. from wall to wall. Angles of jet holes varying from 80 to 110 deg. were tried on different occasions. It was noticeable that the jet marks on the piston—blackened spots—did not change in sympathy with the jet angles. There was a distinct suggestion from these marks that the jets of oil were actually being bent inwards by the boundary walls of the cylinder. Some comparable results obtained with angles of 80, 90 and 100 deg. are given in Fig. 5. The suggestion from these is that 90 deg. is perhaps a little better than 100 deg., while 80 deg. is distinctly worse than 90 or 100 deg.

(d) *Atomisation, Penetration and Distribution*—Proper distribution of the oil is, of course, closely tied up with both atomisation and penetration, and it is not possible to separate the one effect from the other or the cause of the one entirely from the cause of the other, but the results given above and the experiences obtained in trying to arrive at the best characteristics of a sprayer to suit the particular engine under consideration show that penetration is of first importance, distribution of second importance, and that atomisation is the least important of the three.

Detonation

At various times in the course of the trials the engine showed definite evidence of extremely rapid combustion or detonation in the cylinder. These occasions occurred in an apparently haphazard manner, and came and went in a tantalizing fashion. For a considerable time there was an impression that the combustion in the cylinder was too slow for efficient burning, and it was expected that a condition just bordering on the detonation condition would be helpful.

In the course of the experiments with the engine, conditions were finally reached which, quite accidentally, gave the clue to the conditions necessary. When the engine was detonating slightly, a "ping" could be heard in the cylinder at each combustion period. When the detonation was severe, the noise was very considerable. At every revolution of the engine there was a most severe blow on the parts, just as if the crankshaft was receiving the blow of a large steam hammer. The compression pressures usually varied from 280 to 300 lbs. per sq. in., but occasion was taken to reduce this to about 260 lbs. and lower. The engine was often started up as soon as steam pressure was raised in the boiler to a little over 100 lbs. The warming up of the engine took place naturally by thermal circulation from the boiler (or regenerator) to the engine cylinder. The circulation was

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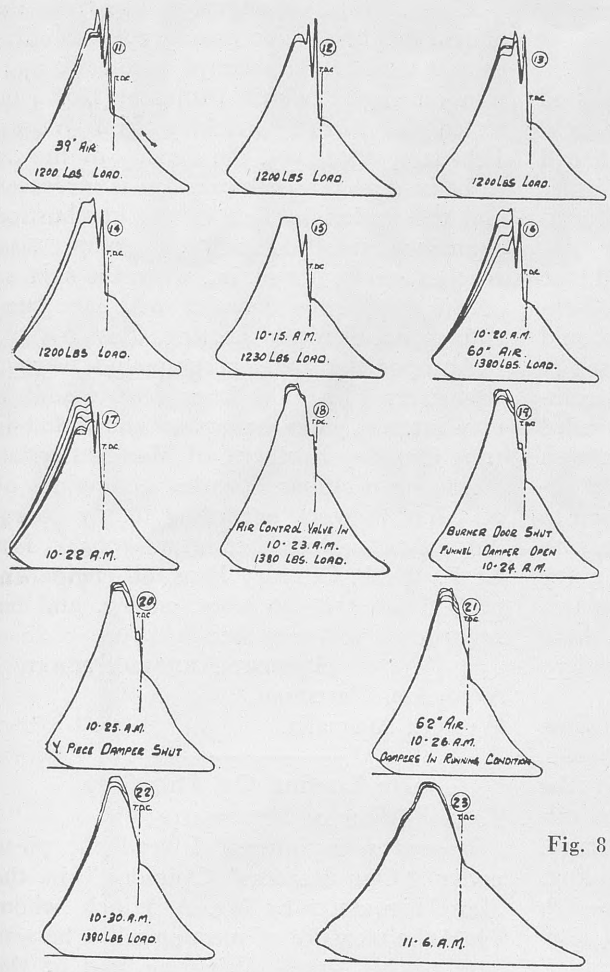

Fig. 8

certain enough, but sluggish at the commencement. As a result, it happened frequently that the engine started up cold. When the combination of a cold engine and low compression pressure occurred together, it was found that detonation was very marked. When this occurred one day, and was repeated the next day, it was felt that what had hitherto been an elusive phenomenon was within reach of explanation. A different sprayer was tried to see if detonation in any way depended upon the type in use, but the detonation occurred just the same. The fuel oil was then changed, but it occurred with petroleum oil just as with shale oil. It was noticed that the detonation became less severe as the engine continued to run and warm up. It was also noted that when more air was blown in the detonation became more severe. On the other hand, as the air pressure increased, with, say, higher revolutions, the severity of the detonation decreased. The evidence, therefore, was accumulating that detonation depended intimately upon the coldness of the air into which the oil was injected. It happened that on one occasion the compression pressure was reduced to 235 lbs. per sq. in., and instead of detonation it was found this misfiring was actually taking place. Quite plainly, therefore, there was a narrow boundary between the one and the other.

A set of cards which shows the one condition merging into the other were obtained, and are shown in Fig. 6. No. 1 card shows pre-ignition taking place, due to oil remaining from the previous stroke, the dotted line indicating what would be a non-firing line. No. 2 shows the existence of the same condition, but the firing is more marked. In No. 3 the condition has changed from one of misfiring to one of detonation. The lateness of ignition will be noted in this case, and cards Nos. 2a, 4, 5, and 6 show evidence of detonation and no evidence of misfiring such as in No. 1.

In Figs. 7 and 8 a series of cards are reproduced showing very violent examples of detonation at starting up. These change into more normal firing cards as the load increases and the engine warms up. It will be noted from these cards that severe detonation accompanies a late commencement of ignition, and it may, therefore, be concluded that it arises from delay in the commencement of ignition caused by an adequate firing temperature in the cylinder, followed by a very rapid burning of the oil which has accumulated between the commencement of injection and the commencement of firing, the accumulated oil being apparently an important factor. In No. 16 and 17 of Fig. 8, a number of cards have been reproduced together. It is worth noting that in each case the initial ignition line is common to them all. From No. 18 onwards normal conditions are being established. There was no evidence found from any results obtained that detonation improved the combustion efficiency. Detonation appears to take effect upon the first portion of the injected oil.

Scavenging as Affected by Piston Shape

The piston with which most of the trials were carried out was one having a deflecting lip in way of the air inlet ports, and washing away to the exhaust side as shown in Fig. 9. This piston was one of three shapes tried. Various experiments that were carried out had shown that scavenging was not as good as could be desired, though this was contrary to what the compression samples that were taken from the engine at different times indicated. The following experimental results show, however, that the normal scavenging obtained was good by comparison with what was obtained by reversing this piston and placing the exhaust side to the scavenging air inlet ports and the deflecting lip to the exhaust ports. This alteration was a simple one to carry out, involving mainly a rearrangement of the fastenings for the piston rings, yet the results are of considerable importance. With the piston reversed, the first impressions during the test were that the reversal of the piston had not spoiled the results, but as the load was increased the loss in efficiency became evident, and it was considered advisable not to increase the brake load beyond 1,330 lbs. instead of the usual 1,400 lbs. or more. Fig. 10 shows the results obtained, with the piston in the correct way and with it reversed. With the piston reversed the efficiency falls off very quickly after 250 b.h.p. is reached. It is, therefore, evident that scavenging can be made worse in this particular engine by the means adopted, and that, therefore, the deflecting lip of the piston serves a useful and necessary purpose. This, however, does not necessarily apply irrespective of the shape of scavenging ports and inlet passages, or other features of scavenging.

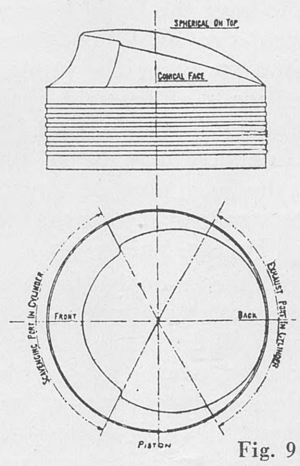

Fig. 9

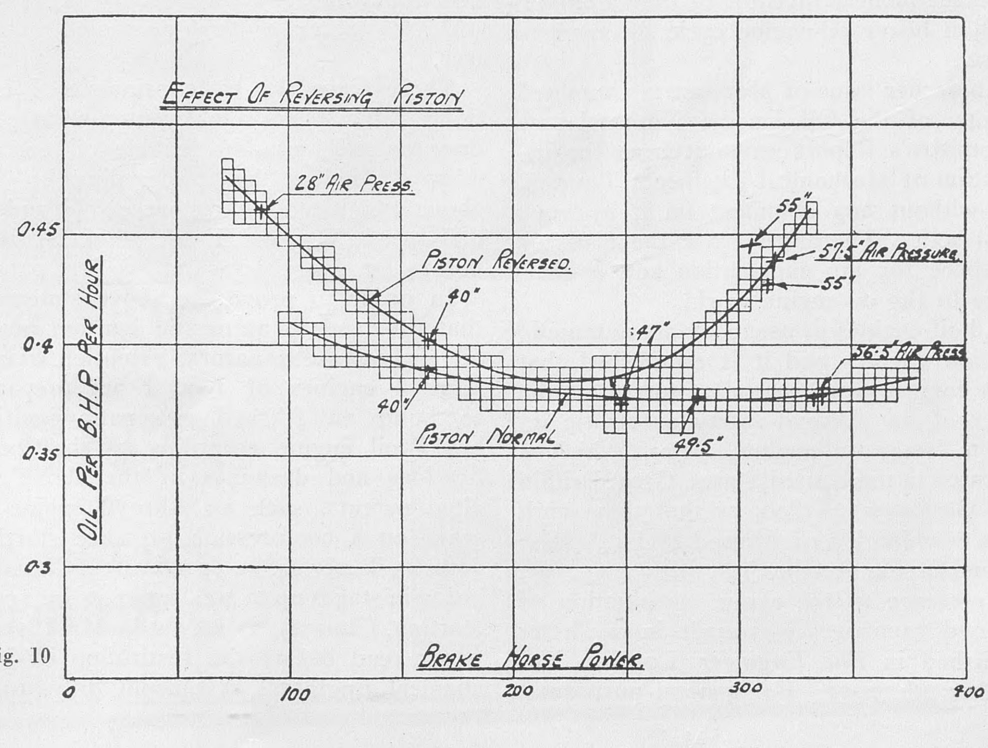

Fig. 10

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Our Readers Opinions

"A Valuable Publication," Says a Pioneer Engine Designer

To the Editor of MOTORSHIP:

I have taken MOTORSHIP since my return from overseas in 1919, and consider it a most valuable publication, both technically and historically. For me, as one of the pioneer engine designers of this coast, it has more than the usual interest.

RICHARD D. WATSON,
Trona, Calif.

Sulzer Engine Is Swiss Design

To the Editor of MOTORSHIP:

In the August number of MOTORSHIP you publish an article by Prof. Mentz entitled "German Oil-Engines for Merchant Ships," in which some Sulzer Diesel engines, built by our associated company at Ludwigshafen-am-Rheim, are described.

The engines in question are the well-known Sulzer two-cycle marine Diesel engines, developed and designed by Sulzer Brothers in their works at Winterthur, Switzerland. It is therefore incorrect to designate these engines as German oil-engines, and we should be much obliged if you would publish a note in your next number calling attention to this.

All Diesel engines built at Ludwigshafen-am-Rhein by our associated company are built from drawings prepared by the Sulzer works at Winterthur, Switzerland, and can therefore only be designated correctly as Swiss type engines.

SULZER BROTHERS, LIMITED.
Winterthur, Switzerland.

Oil Engine Nomenclature

To the Editor of MOTORSHIP:

The issue of MOTORSHIP, June, 1923, page 527, invites the opinion of readers on the above subject. May I take the opportunity to thank you for the earlier letters of mine you have been good enough to publish in your magazine, wherein I state my claim to be the pioneer inventor of the automatic ignition heavy oil-engine cycle, boomed as Diesel.

An earlier issue of MOTORSHIP contained a copy of the Oil Engine Nomenclature Committee's Report sent out from the Institution of Mechanical Engineers, London, but without any comment on it by your good self. Therefore I ask the courtesy of space for my explanation and a challenge to the oil-engine world.

All oil-engines in use today are automatic ignition engines and it is established that such engines work according to one or the other of my Akroyd safety automatic ignition heavy oil-engine cycles, which I patented in the United States, Great Britain and Germany in 1890, or that they work on a combination of Akroyd cycles. (See accompanying sketches.)

Reference to the above combination of Akroyd vaporisers was made in my letter published in *The Engineer*, London, November 4th, 1921. For general purposes I maintain that all oil-engines may be classed under simple and correct terms:

Class 1. Heated or preheated Akroyd automatic ignition.

Class 2. Cold-starting Akroyd automatic ignition.

These terms express the original and true historical evolution of the modern oil-engine. Of course each manufacturer should describe the special patented device used to spray or atomize the liquid fuel for combustion. (For instance, the so-called Diesel has an air blast spray injection with automatic ignition.) And in Class 1 engines they should state the method used to heat the vaporizer or its equivalent, i.e., with lamp or steam or electric device, then every engineer who has been instrumental in this branch of engineering could have his share of honor in the development of the modern oil engine.

I would like to point out that it is often stated in engineering journals, text books, institution papers and the like that the Hornsby-Akroyd is a low compression oil-engine and that the engine cycle is obscure. Such a statement is wrong and misleading. The patent specification No. 15994—8th October, 1890—provides that the oil may be injected on the compression stroke:

"The engine shown in the drawing is designed to have the liquid hydrocarbon injected into the explosion chamber and formed into spray before impinging upon the heated walls of the said chamber, etc., etc." (Page 1, lines 46-47-48.)

"The injection may be so timed as to occur at the beginning or any portion of the suction stroke or during the compression stroke." (Page 2, lines 1-2-3.)

May I ask the favor that further comment on my early Akroyd safety automatic ignition heavy oil engine cycles may refer to my work as a whole, as described in the specifications and drawings of patents No. 7146—May 8, 1890, No. 15994—October 8, 1890, and No. 3909—February 29, 1892. (Akroyd water or fuel oil-cooled vaporizer.)

Those were the basic principles I laid down thirty years ago, eventually to produce an efficient and reliable oil engine. Akroyd engines built according to the above mentioned patents were sold and in daily use in England, France, and Germany before Dr. Diesel took out his first patent.

In order to prove the above statement that the modern automatic ignition heavy oil engines are a natural evolution of my Akroyd engines of 1890 I am prepared to build an Akroyd automatic ignition heavy oil engine according to the specifications and drawings of the above recited patents, such an Akroyd engine to work on a compression pressure starting from 45 lb. per sq. in. (pre-heated, Class 1), rising in stages up to 400 lb. per sq. in. (cold starting, Class 2), as set out in Mr. Liven's paper read before the Institution of Mechanical Engineers at Lincoln, July, 1920.

That Akroyd oil engine to use from the start a fuel of specific gravity 0.854, similar to that used in the Akroyd automatic ignition oil engine which Professor Robinson tested for me at Bletchley Iron Works, February, 1891, and the density of the oil to be increased as compression is increased and the cooled surface of the combustion chamber extended, until the compression reaches 400 lb. per sq. in., when the surface of the combustion chamber will have been entirely cooled (cold-starting, Class 2).

Apropos the dual or compound Akroyd vaporizers (Two Oil Injection Method) it may interest your readers to know that in 1905 Crossley Brothers, of Manchester, altered one of ttheir Crossley oil-engines of 20 b.h.p. to work according to my patent No. 28,045—December 21st. 1904. Mr. Le P. Webb, Crossley Bros. oil engine expert, tested that 20 b.h.p. engine, and his report on it was very satisfactory.

HERBERT AKROYD STUART.
Akroydon, Claremont,
Western Australia.

No Loafing On This Ship

To the Editor of MOTORSHIP:

It was with interest I read the piece under "Our Readers' Opinions" in the May MOTORSHIP by Mr. A. Hinch, whom I had the pleasure of meeting when he was here on his ship. What he said of the RHEINLAND is correct. I saw her after he did, and No. 1 cylinder of starboard engine was also out of commission, the A frame having broken the same as No. 6, carrying the pipes, camshafts, muffler manifold, etc., two feet up in the air. This was repaired by the ship's engine crew unaided, so they told me, by cutting out Nos. 1 and 6 and making a four-cylinder engine of it. She was still making twelve knots.

I think it is truly wonderful that a breakdown of such a serious character as this can be repaired by the engine-room crew and the ship continue on her route.

NELSON E. KELLOGG.
Port Engineer,
Agusan Coconut Co.,
Cebu Cebu, P. I.

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